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# TOWARDS ECOSYSTEM-BASED PLANNING: A PERSPECTIVE ON CUMULATIVE ENVIRONMENTAL EFFECTS

**Prepared by Katherine Davies, D.Phil.**
**Ecosystems Consulting Inc.**

**for**
**THE ROYAL COMMISSION ON THE FUTURE OF THE TORONTO WATERFRONT**
**and**
**ENVIRONMENT CANADA**

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# TOWARDS ECOSYSTEM-BASED PLANNING:
# A PERSPECTIVE ON CUMULATIVE ENVIRONMENTAL EFFECTS

**Prepared For**

**The Royal Commission on the Future of the Toronto Waterfront**
**and Environment Canada**

KATHERINE DAVIES D.PHIL.
ECOSYSTEMS CONSULTING INC.

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## FOREWORD

This project developed from a study on ecosystem health conducted for the Royal Commission on the Future of the Toronto Waterfront as part of the Environmental Audit of the East Bayfront/Port Industrial Area. During the Environmental Audit it became clear that the existing land use planning processes in the Greater Toronto Bioregion were not designed to consider the cumulative environmental effects of multiple human activities. Although the work contained herein is original, it is based on ideas generated during previous research conducted under contract to the Federal Environmental Assessment Review Office (FEARO). FEARO has permitted the use of these ideas for this project. This project was undertaken in partnership with Environment Canada through the Great Lakes Pollution Prevention Initiative in recognition of the importance of cumulative effects assessment in responsible decision-making.

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## SUMMARY

The current interest in cumulative environmental effects is an example of a paradigm shift from a somewhat limited concept of the environment towards a more holistic way of perceiving and interacting with the ecosystems of which we are a part. In many respects, all environmental effects are cumulative in that they are always part of interactive ecosystems, with pre-existing stresses and effects. Cumulative environmental effects should not be seen as a separate or new type of environmental effect, but rather as signifying a better understanding of the nature of the relationships between human activities and the ecosystems in which they occur.

Although assessments of cumulative environmental effects have not yet been integrated into environmental planning and management activities in the Greater Toronto Bioregion, there is a growing awareness of the need to do so. The overall objective of this report is to explore how cumulative environmental effects can be addressed in these activities.

Concepts and definitions of cumulative environmental effects have evolved over time. Early definitions, recognised that many biophysical environmental effects are cumulative. This has now evolved to an understanding that assessing cumulative environmental effects requires combining scientific information and criteria with human values in a goal-oriented planning process for variable, but often extended, time frames and spatial boundaries. In this project, cumulative environmental effects are defined as including social, economic and biophysical considerations, as well as the interactions among them. Specifically they can be defined as:

- The combined effects of all activities in an area over time; and
- The incremental effects associated with individual projects in an area over time.

A consideration of the combined effects of all activities in an area over time is a prerequisite to addressing the incremental effects associated with individual projects in an area over time.

Cumulative environmental effects are rarely mentioned in legislation. The only country where this term appears repeatedly is the U.S. In Canada, the proposed Canadian Environmental

Assessment Act (Bill C-78) will require proponents and others to consider cumulative environmental effects in environmental assessments.

Two of the most important environmental planning and management processes in the Greater Toronto Bioregion are those established under the Planning Act and the Environmental Assessment Act. However, until recently environmental considerations have rarely been included in land use planning. Environmental assessments do not often describe the context of the proposed project adequately in terms of the pre-existing state of ecosystem health and goals or criteria that can be used to judge the acceptability of the project. This report proposes a process for ecosystem-based planning that would take into account the social, economic and biophysical components of ecosystems and the interactions between them and consider how alternative scenarios would promote and protect ecosystem health.

Such an ecosystem-based planning process would:

- Use a holistic approach to address cumulative environmental effects by:

  -Synthesising information and values in an ongoing, multistakeholder process;

  -Ensuring coordination and collaboration between different government departments and agencies;

- Establish goals and maximum acceptable levels of stress in the social, economic and biophysical components of the ecosystem taking into account the interactions between these ecosystems, recognising that imposing 'limits to growth' may not be equitable in terms of the economic potential in different communities (compensation may be required);

- Examine the current state of the ecosystem;

- Explore the nature and extent of human activities that are compatible with the protection and promotion of ecosystem health;

- Recognise that incremental decision-making is a major contribution to cumulative environmental effects in general and that multiple decisions about small projects are very important; and

- Ensure that the resulting plan incorporated some flexibility for scenarios that were not considered in the planning process, but also ensure implementation of the goals.

There are many human activities that have cumulative environmental effects in the Greater Toronto Bioregion. These include:

- Physical restructuring of the landscape, such as lakefilling, drainage or infilling of wetlands and the construction of buildings and roads;

- Additions of materials or energy, such as emissions of persistent toxic chemicals into air and water and the use of fertilisers;

- Removal of renewable and non-renewable resources, such as water, fish and sand and gravel; and

- Introduction of non-native species, such as the sea lamprey and the zebra mussel.

All levels of government are involved in environmental planning and management activities, and within each level there are often several departments or ministries involved. This indicates that the procedural arrangements for addressing cumulative environmental effects are complex. Environmental planning and management activities in the Greater Toronto Bioregion include the Great Lakes Water Quality Agreement, the Lake Ontario Toxics Management Plan, the Metro Toronto Remedial Action Plan, the Municipal-Industrial Strategy for Abatement, the proposed Clean Air Program, and the Metropolitan Toronto and Region Conservation Authority's Greenspace Plan for the Greater Toronto Area. There is also a relatively large amount of information available on the ecosystem in the Greater Toronto Bioregion, compared with other regions of Canada. Environmental monitoring programs from which the state of ecosystem health can be deduced include the Canadian Wildlife Service's herring gull program, and the

Ontario Ministry of the Environment's nearshore juvenile fish contaminants surveillance program, sport fish contaminant monitoring program, and its work on water and sediment quality in the Toronto nearshore zone.

A generic framework for ecosystem-based planning could consist of the following activities:

- Scoping
  - Clarifying the purpose of the plan;
  - Establishing the spatial and temporal boundaries to which the plan will apply;
  - Identifying key issues and concepts, including the major types of human activities and cumulative environmental effects in the area; and
  - Defining who the stakeholders are;

- Establishing goals and maximum acceptable levels of ecosystem stress
  - Biophysical components of the ecosystem;
  - Social components of the ecosystem;
  - Economic components of the ecosystem; and
  - Interactions among them;
  - 'Valued characteristics' of the social, economic and biophysical ecosystems to be used in the plan;

- Defining roles and responsibilities for the different stakeholders;
  - Working arrangements and procedures; and

- Assessing current ecosystem health by determining the status of the 'valued characteristics' using the goals and maximum acceptable levels of ecosystem stress;

- Identifying alternative scenarios for the nature and extent of future human activities, for example:
  - The development and use of resources such as water, agricultural land and fisheries;
  - The development, redevelopment or expansion of human settlements; and
  - The development of opportunities for recreation and tourism.

- Predicting the cumulative environmental effects of the alternative scenarios on the 'valued characteristics' using the goals and maximum acceptable levels of stress;

- Deciding on the preferred alternative, taking into account tradeoffs between the goals or between different resource uses as well as the amount of uncertainty involved in the predictions;

- Developing operational requirements to implement the preferred alternative and an ongoing monitoring program.

It should be noted that several of these steps, especially scoping, should be regarded as iterative activities throughout the planning process.

An ecosystem-based planning process, such as that outlined in this report, could be integrated into the land use planning process in the Greater Toronto Bioregion, but legislative, policy and procedural amendments would be required. In addition, there would be significant resource implications (personnel and financial) for municipalities and agencies. However, the benefits would far outweigh these 'costs' and the implementation of such a process would represent a demonstration of the concept of 'anticipate and prevent'.

1

# INTRODUCTION

## 1.1 Background

Traditionally, concepts of the environment in western societies have been somewhat limited. The environment has been seen as being composed of the natural landscape including the earth's physical structure (land, air, water) and the biota (plants, animals, bacteria and fungi) that inhabit it. In addition, many societies have seen themselves as largely separate from the environment. This concept is evident in various definitions. The Oxford English Dictionary defines the environment as:

> "the objects or the region surrounding anything...The conditions under which any person or thing lives or is developed."

In the last fifteen years, a more dynamic and interconnected concept of the environment has evolved, based on the idea of an ecosystem. This sees humans as integral components of living systems and emphasises function, rather than structure. Indeed, most definitions of biophysical ecosystems focus on interactions and proximity. As a result of this evolution, we are now in a paradigm shift towards a more holistic way of perceiving and managing the world around us.

The current interest in cumulative environmental effects is an example of this paradigm shift. It is now apparent that the presence of multiple human activities and natural processes in a given ecosystem can have cumulative environmental effects. Thus, the environmental effects of human activities should not be seen as isolated events in space and time, but as interacting with pre-existing environmental conditions and contributing to the future ecosystem health status of an area. In many respects, all environmental effects are cumulative in that they are always part of interactive ecosystems, with pre-existing activities, processes and effects, but the concept of cumulative environmental effects recognises the profound complexity of the relationships in ecosystems in ways that have not been reflected in traditional environmental planning and management activities. Thus, cumulative environmental effects should not be seen as a separate or new type of environmental effect, but rather as signifying a better understanding of

the nature of the relationships between human activities and the ecosystems in which they occur.

In this report, the word ecosystem has been used wherever possible to denote a holistic understanding. However, the words environment or environmental have been used in several accepted phrases, such as cumulative environmental effects, environmental planning and management and environmental assessment, because they are frequently used.

## 1.2 Context For This Report

Efforts to improve our understanding of the world around us are becoming apparent in many environmental planning and management activities. In many cases, these efforts are focusing on implementing the ecosystem concept or on addressing cumulative environmental effects. For example, the proposed Canadian Environmental Assessment Act (Bill C-78) will require proponents and responsible authorities to address cumulative environmental effects in environmental assessments. This is discussed in section 3 of this report. In addition, several regional monitoring programs, such as the recently announced federal/provincial program on the Peace, Athabasca and Slave River drainage system in Alberta, are taking cumulative environmental effects into account. Another example of an initiative to apply the ecosystem concept is the multi-year, multi-department study of global warming on the Mackenzie Basin. This study is examining the possible effects of global warming on the social, economic and biophysical components of the ecosystem in general, and in particular the interactions between these effects, so that a 'causal web' can be established.

There are also several initiatives underway in the Great Lakes Basin and the Greater Toronto Bioregion. In 1978, the federal governments of Canada and the U.S. formally adopted an ecosystem approach for managing the Great Lakes in the Great Lakes Water Quality Agreement. This recognised the complexity of the interactions occurring in the ecosystem and that it was necessary for different jurisdictions to work together to restore and protect the Great Lakes. The Agreement also implicity endorsed a preventive approach to restoration and protection. This is evident in the commitment of the Parties that:

"The discharge of toxic substances of any or all persistent toxic substances be virtually eliminated" (Article II(b))."

Preventive approaches to managing the Great Lakes will be developed in the very near future by, for example, the IJC's Virtual Elimination Task Force and the proposed Canadian - U.S. Pollution Prevention Centre.

The Remedial Action Plan process for the Metro Toronto Waterfront also recognises the complexity of the relationships between human activities and their associated effects. The Remedial Action Plan is a joint program of Environment Canada and the Ontario Ministry of the Environment. It was initiated in response to a request from the IJC for Remedial Action Plans to be developed for each of the 42 'areas of concern' in the Great Lakes Basin. The Public Advisory Committee has developed twelve goals that emphasise the importance of a healthy, diverse ecosystem in the Toronto Waterfront. The process of developing the Remedial Action Plan could be seen as including consideration of cumulative environmental effects, in that it is using an ecosystem approach to study the Metropolitan Toronto Waterfront and watersheds and recommend remedial strategies.

In addition, aspects of the provincial Planning and Environmental Assessments Acts are currently being reviewed by several groups including a multi-disciplinary workgroup of the Royal Commission on the Future of the Toronto Waterfront. It has already been recognised that neither Act specifically addresses cumulative environmental effects. For example, a recent report by the Ontario Environmental Assessment Advisory Committee (EAAC) on a development on the Ganaraska River mentioned that Official Plans "do not require consideration of cumulative environmental effects" (Ontario Environmental Assessment Advisory Committee, 1989). Another report by EAAC made a similar point in relation to the Etobicoke motel strip (Ontario Environmental Assessment Advisory Committee, 1988).

The Royal Commission on the Future of the Toronto Waterfront has acknowledged that cumulative environmental effects are not taken into account in existing land use planning processes in the Greater Toronto Bioregion. In its second interim report, entitled 'Watershed', the Commission reported that it was:

"told that the existing land-use control system is inadequate in taking into account cumulative effects of development on the environment" (Royal Commission on the Future of the Toronto Waterfront, 1990).

Thus, although assessments of cumulative environmental effects have not yet been integrated into environmental planning and management activities in the Greater Toronto Bioregion, there is a growing awareness of the need to do so. This report is intended to encourage the consideration of cumulative environmental effects in these activities in the region.

### 1.3 Outline of This Report

The overall objective of this report is to explore how cumulative environmental effects can be addressed in environmental planning and management activities in the Greater Toronto Bioregion. Most, if not all, of the existing initiatives on cumulative environmental effects are based on aquatic ecosystem or drainage basins. This report is probably unique because it is intended to develop processes to assess cumulative environmental effects in a region containing several watersheds where portions are already heavily urbanised and where there are pressures for the remaining land to be developed. Thus, the cumulative environmental effects in the Greater Toronto Bioregion are likely to be somewhat different from those in rural aquatic ecosystems or drainage basins.

Initially, a discussion paper was prepared to familiarise interested individuals with the concept of cumulative environmental effects and to propose a generic framework that could be used to assess cumulative environmental effects in the Greater Toronto Bioregion. Subsequently, a workshop was held to review the discussion paper and to consider how assessment of cumulative environmental effects could be addressed in environmental planning and management processes in the Greater Toronto Bioregion. This was done by applying the proposed framework to three situations:

- The Oak Ridges Moraine;
- The Humber Watershed; and
- Waterfront planning in Mississauga.

The workshop participants, including representatives from federal, provincial and municipal governments and others (see Appendix 1), were requested to work through the proposed framework using the Planning Act and the Environmental Assessment Act to consider how cumulative environmental effects could be considered in planning in these three situations, as well as in a project-specific environmental assessment. Following the workshop, the discussion paper was revised and extended to form this report.

2

# CONCEPTS AND DEFINITIONS OF CUMULATIVE ENVIRONMENTAL EFFECTS

## 2.1 Characteristics of the Main Concepts and Definitions of Cumulative Environmental Effects

The concept of cumulative environmental effects is not new, but it has only attracted attention in the last few years. For example, in the last five years the Canadian Environmental Assessment Research Council (CEARC) has published several reports on cumulative environmental effects (Canadian Environmental Assessment Research Council and the U.S. National Research Council Board on Basic Biology, 1986; Sonntag et al., 1987; Peterson et al., 1987; Canadian Environmental Assessment Research Council, 1988; Lane et al., 1988). In addition, there is a growing amount of information being generated in the U.S. on cumulative environmental effects. Most recently, the U.S. Conservation Foundation has published several documents on this subject (Conservation Foundation, 1988, 1990).

Concepts and definitions of cumulative environmental effects have evolved over time. Table 1 summarises the characteristics of the main concepts and definitions of cumulative environmental effects from 1978 to date. It is based on work by the Conservation Foundation (1990). The table demonstrates the chronological development of ideas about cumulative environmental effects. Initially, there was a recognition that many biophysical environmental effects are cumulative. The Council on Environmental Quality's 1978 definition (Council on Environmental Quality, 1978) encompasses past, present and future actions in an area, as well as multiple activities and direct and indirect effects. Odum (1982) pointed out that incremental decision-making is a key contributor to cumulative environmental effects. Also in 1982, Vlachos (1982) suggested that there were three dimensions to cumulative environmental effects: aggregation (i.e., the sum of the effects), interaction (i.e., how the effects interact) and diachronicity (i.e., how the effects overlap in time). Clark (1986) repeated the earlier emphasis on the importance of effects in time and space. These ideas were expanded on by Sonntag et al. (1987) in a typology of cumulative environmental effects. The typology identified eight types of effects. These are shown in Table 2, together with examples from the Greater Toronto Bioregion.

**TABLE 1: CHARACTERISTICS OF THE MAIN CONCEPTS AND DEFINITIONS OF CUMULATIVE ENVIRONMENTAL EFFECTS: 1987 - TO DATE**

| | | |
|---|---|---|
| Council on Environmental Quality,1978 | • | Emphasised the incremental impacts of an action;<br>• Time-oriented. |
| Odum, 1982 | • | The implications of incremental decision-making. |
| Vlachos, 1982 | • | Identified three dimensions of cumulative environmental effects; aggregation, interaction and diachronicity. |
| Clark, 1986 | | Stressed:<br>• Impacts that are cumulative in space;<br>• Impacts that are cumulative in time. |
| Sonntag et.al., 1987 | • | Proposed a typology of cumulative environmental effects (time crowding, space crowding, compounding effects, time lags, extended boundaries, triggers and thresholds, indirect effects and patchiness effects) |
| Peterson et al., 1987 | • | Emphasised functional pathways by which effects accumulate |
| CEARC, 1988 | • | Stressed frequency in time, density in space, and synergism |
| Lane et al., 1988 | • | Emphasised frequency in time, density in space, and combined effects (periodic and synergistic) |
| Bedford and Preston, 1988 | • | Critique of concepts and definitions |
| Lee and Gosselink, 1988 | • | Described the need to develop social and political values and goals to assess and manage cumulative environmental effects |

**TABLE 2: A TYPOLOGY OF CUMULATIVE ENVIRONMENTAL EFFECTS**

| TYPE | MAIN CHARACTERISTICS | EXAMPLES |
|---|---|---|
| Time Crowding | Frequent and repetitive effects on a single environmental medium | Effects of lakefilling on water quality |
| Space Crowding | High density of effects on a single environmental medium | Effects of automobile emissions on air quality |
| Compounding Effects | Synergistic effects arising from multiple sources on a single environmental medium | Effects on water quality in the Toronto Waterfront from many sources including sewage treatment plants, CSOs, SSOs, rivers entering the waterfront and atmospheric deposition |
| Time Lags | Long delays in experiencing effects | Latency periods associated with the effects of carcinogenic chemicals |
| Extended Boundaries | Effects resulting some distance from the source | Long range transportation of atmospheric pollutants into the Greater Toronto Bioregion |
| Triggers and Thresholds | Disruption to ecological processes that fundamentally change system behaviour | Species extinction |
| Indirect Effects | Secondary effects resulting from a primary activity | Development in the upper reaches of the Don River causing sedimentation in the lower River and the Keating Channel |
| Patchiness Effects | Fragmentation of ecosystems | Fragmentation of wildlife habitat in the developed areas of the Greater Toronto Bioregion |

Notes: 1. This table is based on the typology in Sonntag et al. (1987)

2. Many of the examples used in the table illustrate more than one type of cumulative environmental effect. In fact, cumulative environmental effects are usually a combination of several of the different types outlined above. Thus, it is difficult to identify examples that apply to one type of effect only.

Peterson et al. (1987) described the "basic functional pathways" that contribute to cumulative environmental effects and suggested that there were four main types. These are shown in Table 3.

In 1988, the Canadian Environmental Assessment Research Council defined cumulative environmental effects as:

> "impacts on the natural or social environment (that) take place so frequently in time or densely in space that the effects of individual "insults" cannot be assimilated, or the impacts of one activity combine with those of another in a synergistic manner" (Canadian Environmental Assessment Research Council, 1988).

This definition encompasses many of the ideas expressed in earlier concepts and definitions and is commonly used today. Lane et al. (1988) built on this definition and emphasised time, space and the combined effects of different activities. Bedford and Preston (1988) pointed out that the assessment of cumulative environmental effects is confounded by the variety of concepts and definitions used.

Although they did not attempt a definition of their own, Bedford and Preston recognised the importance of value judgements in the assessment process. This idea was further developed by Lee and Gosselink (1988) who argued that the identification and development of commonly-held goals is central to the assessment of cumulative environmental effects. They went on to suggest that technical information must be linked to goals in the design of approaches to manage cumulative environmental effects.

Thus, concepts and definitions of cumulative environmental effects have evolved over time from an initial understanding of the biophysical considerations involved to a recognition that assessing cumulative environmental effects requires combining scientific information and criteria and human values in a goal-oriented planning process for variable, but extended time frames and spatial boundaries.

**TABLE 3: BASIC FUNCTIONAL PATHWAYS THAT CONTRIBUTE TO CUMULATIVE ENVIRONMENTAL EFFECTS**

| PATHWAY | MAIN CHARACTERISTIC | EXAMPLE |
|---|---|---|
| Slowly Dissipative | Effects that accrue from a single source in an additive manner | Effects of salt on roadside vegetation |
| Magnification | Effects that accrue from a single source in a synergistic manner | Biomagnification of PCBs up the Great Lakes food web |
| Multiple Effects | Effects that accrue from multiple sources in an additive manner | Effects of CFCs and $CO_2$ on climate |
| Synergistic Relationships | Effects that accrue from multiple sources in a synergistic manner | Formation of smog from NOx and hydrocarbons in the presence of UV radiation |

Note: Based on Peterson et al. (1987)

Bedford and Preston (1988) concluded that there are tools available to conduct qualitative assessments of cumulative environmental effects, but that additional research and development is needed to be able to quantify cumulative environmental effects. Most researchers agree that no single method is appropriate for all phases of the assessment process. This section provides a summary of existing methods and the circumstances in which they are most useful. References are provided, where available, so interested readers can explore individual methods more fully.

Shopley and Fuggle (1984) identified eight categories of methods for assessing cumulative environmental effects. The first three methods are useful to scope the issues involved in an assessment of cumulative environmental effects. The remaining five are useful in the assessment phase itself. The eight categories of methods are shown in Table 4.

## 2.2 The Concept and Definition of Cumulative Environmental Effects Used in This Report

In this report cumulative environmental effects are defined as including social, economic and biophysical considerations, as well as the interactions among them. Specifically, they can be defined as:

- The combined effects of all activities in an area over time; and
- The incremental effects associated with individual projects in an area over time.

This definition emphasises the combination of effects in an ecosystem, as well as the incremental effects of individual projects. To assess the incremental effects of new activities it is necessary to have an understanding of the existing cumulative effects, i.e., the combined effects of all activities in the area. Thus, the first part of this definition is a pre-requisite for the second part. The combined effects of all activities in an area over time should probably be seen as primarily being a government responsibility, whereas assessing the incremental effects of individual projects is more likely to be the responsibility of a proponent or developer. Thus, the

**TABLE 4: SUMMARY OF METHODS FOR ASSESSING CUMULATIVE ENVIRONMENTAL EFFECTS**

| METHODS | USE | REFERENCE |
|---|---|---|
| Ad hoc techniques | To assemble information for use in scoping | N/A |
| Checklists | In initial documentation of cumulative environmental effects | Westman, 1985 |
| Matrices | To display initial broad judgements about the causes of cumulative environmental effects and identifying interactions | Leopold, 1971 |
| Networks | To classify, organise and display problems, processes and interactions | Everitt at al., 1986 |
| Cartographic techniques | To display the sum of natural succession, development and associated visual landscape effects associated with multiple projects | Lewis, 1976 |
| Mathematical | To estimate and communicate long-term and indirect effects, in conjunction with other techniques (requires quantitative information) | Armour and Williamson, 1986 |
| Evaluation techniques | To compare the effects of alternative scenarios | Westman, 1985 |
| Adaptive methods | Assumes that no single technique is appropriate for all stages of an assessment of cumulative environmental effects. Uses a combination of methods | Dames and Moore Inc., 1981 |

Source: Based on Shopley and Fuggle (1984).

former is part of ecosystem planning for a region, whereas the latter is more related to project-specific environmental assessments.

The definition outlined above emphasises the additive and synergistic aspects of cumulative environmental effects, such as additions of persistent toxic chemicals to the environment. However, cumulative environmental effects frequently involve progressive loss, such as filling in of wetlands and soil erosion. It is also important to remember that cumulative environmental effects are not always negative. Frequently, an activity will have several cumulative effects, some of which are positive, e.g., job creation and increases in recreational opportunities and some of that are negative, e.g, loss and fragmentation of wildlife habitat.

It is important to stress that this report does not view cumulative environmental effects as a new or separate type of environmental effect, but rather as a more holistic way of understanding how the ecosystems around us function. A better understanding of cumulative environmental effects could
profoundly alter the ways in which the environmental effects of human activities are assessed, monitored and managed.

Decision-making processes that address cumulative environmental effects should always be based on a holistic understanding of the conditions in the area being studied, and they should also predict or assess how these conditions have changed or are likely to change, given alternative scenarios. These and other components of decision-making processes that address cumulative environmental effects are discussed more fully in section 4.4.

3

## CUMULATIVE ENVIRONMENTAL EFFECTS IN LEGISLATION

Cumulative environmental effects (or impacts) are rarely mentioned in legislation. The only country where this term appears repeatedly is the U.S.The first legislative requirement for cumulative effects assessment in the U.S. was included in the regulations under the National Environmental Policy Act (1969). Following this, cumulative environmental effects have been mentioned in ten federal statutes, as well as in 61 sets of regulations and in numerous state laws. Table 5 lists the U.S. federal statutes that mention cumulative environmental effects (Conservation Foundation, 1990). Within the ten statutes listed, there are 17 instances where cumulative environmental effects (or impacts) are mentioned. It is interesting to note that all of these laws were passed (or revised) in 1989. It is unclear why the phrase cumulative environmental effects (and impacts) became much more widespread in 1989.

As a result of the legislative emphasis on cumulative effects assessment, there has been a focus on definitional issues and the development of methods in the U.S. Relatively little attention has been paid to developing conceptual frameworks for cumulative environmental effects. This is very different from the situation in Canada, where until recently research has concentrated on understanding broad theoretical considerations.

The proposed Canadian Environmental Assessment Act (Bill C-78), announced by the federal Minister of the Environment in June 1990, contains a requirement for proponents and others to consider cumulative environmental effects in environmental assessments. Specifically:

Section 11(1) of Bill C-78 states that:

"Every screening or mandatory study of a project and every mediation or assessment by a review panel shall include a consideration of the following factors:

**TABLE 5: U.S. FEDERAL STATUTES THAT MENTION CUMULATIVE ENVIRONMENTAL EFFECTS**

| STATUTE | DATE | TYPE OF CUMULATIVE EFFECTS |
|---|---|---|
| Toxic Substance Control Act | 1989 | Chemical |
| National Forests, Establishment and Administration | 1989 | Forests and Mining |
| Food, Drug and Cosmetic Act | 1989 | Chemical |
| Surface Mining Control and Reclamation | 1989 | Mining |
| Water Pollution Prevention and Control | 1989 | Water |
| Energy Policy and Conservation | 1989 | Energy |
| Air Pollution Control | 1989 | Air |
| Ocean Thermal Energy Conversion | 1989 | Oceans, Energy |
| Outer Continental Shelflands | 1989 | Oceans, Energy |
| Federal Aviation Act | 1989 | Air |
| National Environmental Policy Act | 1989 | General |

Source: Conservation Foundation, 1990.

a) The environmental effects of the project, including.....any cumulative environmental effects that are likely to result from the project in combination with other projects that have been or will be carried out;"

and

Section 14(4) states that:

"Where a responsible authority uses or permits the use of a class screening report, it shall ensure that any adjustments are made that in the opinion of the responsible authority are necessary to take into account local circumstances and any cumulative environmental effects that in the opinion of the responsible authority are likely to result from the project in combination with other projects that have been or will be carried out."

The effect of these two statements is that proponents, responsible authorities, mediators and review panels will be required to ensure that cumulative environmental effects are considered in environmental assessments for individual projects and in class assessments. Cumulative environmental effects will also have to be assessed in the consideration of alternative projects, mitigation/compensation, and follow-up programs.

The proposed Act does not define cumulative environmental effects, and hence it is unclear what will be expected of proponents, responsible authorities and others. The Federal Environmental Assessment Review Office has recently initiated work to examine what will be required of proponents and others to satisfy the legislation in this regard.

There are no requirements in provincial environmental assessment legislation for cumulative environmental effects to be assessed. However, in the definitions section of Ontario's Environmental Assessment Act the environment is defined as:

"(i) air, land or water,

(ii) plant and animal life, including man,

(iii) the social, economic and cultural conditions that influence the life of man or a community,

(iv) any building, structure, machine or other device or thing made by man,

(v) any solid, liquid, gas, odour, heat, sound, vibration or radiation resulting directly or indirectly from the activities of man, or

(vi) any part or **combination of the foregoing and the inter-relationships between any two or more of them,** in or of Ontario". (Section 1(c)). (emphasis added).

This is the closest that any provincial legislation comes to requiring assessments of cumulative environmental effects. But it does not take account of any of the fundamental concepts of cumulative environmental effects, such as temporal and spatial considerations and the synergistic or additive effects resulting from multiple projects.

4

# ADDRESSING CUMULATIVE ENVIRONMENTAL EFFECTS IN DECISION-MAKING PROCESSES

## 4.1 Introduction

If cumulative environmental effects are to be successfully assessed, monitored and managed, they must be addressed in environmental planning and management activities. In particular, it will be important to ensure that they are considered in relevant decision-making processes. This section briefly reviews the decision-making processes established under the Planning Act and the Environmental Assessment Act and discusses if, and how they could be used to address cumulative environmental effects. It concludes that a new process of ecosystem planning is needed. This new process could evolve from existing processes.

## 4.2 Land Use Planning

Land use planning is not a single process, but rather an approach or a way of organising ideas. Richardson (1989) defined it as:

> "making considered decisions about how people should make use of (or leave unused) some part of the earth's surface, having regard to known and expected circumstances and to given aims and/or criteria."

He goes on to describe the ideal elements of the planning process as including:

"• Explicit goals, a goal being a desired state or condition embodying consciously chosen values and priorities;

• Identification of land-related problems and issues;

• Anticipation - attempting to foresee and allow for changing circumstances and future needs and problems;

- Comprehensiveness,.. taking into account as far as possible all considerations and all information relevant to the goals and issues with which the program is concerned, and involving all land-related public programs and the agencies responsible for them;

- Continuity over time, recognising the need for modification, adaptation and revision to respond to changing circumstances;

- Systematic application, following a thought-out procedure, but at the same time with the flexibility to be capable of adapting to special or unforeseen situations;

- Responsibilities that are clearly defined and based on ultimate political authority;

- Opportunities for participation by those involved or affected, including:

    - Land use owners and occupants
    - All public agencies having land-related responsibilities; and
    - Those who will be charged with realising the plans;

- Options provided for the ultimate decision-takers, with a clear understanding of their implications;

- An awareness of the means, limitations and costs of the implementation of plans, incorporated from the very first."

Thus, according to Richardson (1989), a properly conducted land use planning program will normally consist of:

- Gathering information and identifying issues;
- Establishing goals;
- Developing and evaluating options (with effective participation by all affected interests), including implementation programs;
- Putting into effect program coordination and other means of plan implementation;
- Continuous monitoring, periodic review, and eventual revision of the plan."

In most cases, land use planning is conducted by government agencies to determine the nature and extent of permissable land uses. In many respects, land use planning could be used as a basis for addressing cumulative environmental effects. However, it has several limitations, including the following:

**Values and Attitudes**

Land use planning is ultimately a mechanism whose use will depend on prevailing cultural and societal values and attitudes. Cumulative environmental effects will only be addressed in land use planning when they are considered to be sufficiently important. Thus, it may be necessary to change prevailing cultural and societal values and attitudes to recognise the value of addressing cumulative environmental effects. This task involves promoting the concept and educating people, and goes well beyond the scope of land use planning itself.

**Implementation**

A second limitation of land use planning is that plans are always dependent on implementation. However good a land use plan is, it means little unless it is translated into action. The implementation of land use plans has not, in general, been very successful. For example, in

Ontario most proposed developments require approval to amend land use plans (e.g., Official Plan Amendments) rather than being in compliance with them.

**Focus**

Richardson's description of land use planning presents it as a comprehensive activity that addresses all aspects of human activity related to land use. In practice, however, land use planning is usually restricted to defining what types of development should occur where. Thus, it uses a very anthropocentric approach by assuming that land is a resource for human use. It does not normally address the biophysical ecosystem in any great detail because it focuses more on the social and economic aspects of how land is used. In general, land use plans do not contain goals for the biophysical ecosystem, although this is now beginning to change and several Ontario municipalities are now including environmental policy statements in their Official Plans. Unless land use planning includes an assessment of the biophysical ecosystem, it cannot be used to address the full range of social, economic and biophysical cumulative environmental effects.

### 4.3 Environmental Assessment

Like land use planning, environmental assessment is not a single process, but rather an approach or way of organising ideas. It can be defined as a planning process to anticipate and prevent the ecological and related implications of human activities. It can be used to predict and assess the effects of individual projects, programs or policies and for strategic and integrated resource planning. Environmental assessment was developed as a technical and scientific process to describe the effects on the physical environment caused by a single project or activity.

Most project-specific environmental assessments consist of the following components:

- A rationale for the project;
- An assessment of the environmental conditions;

- Public participation;
- Alternative means for carrying out the project;
- An assessment of the environmental effects of the project and its alternatives; and
- Ways of preventing, mitigating or compensating for the predicted environmental effects.

Unlike land use planning, environmental assessments are prepared by proponents or developers and are submitted to regulatory agencies. Clearly, these agencies should ensure that projects proposed in environmental assessments comply with any land use plans.

There are several limitations associated with environmental assessment. Some of these are described below.

**Values and Goals**

Like land use planning, environmental assessment is ultimately a mechanism whose use will depend on prevailing cultural and social values and attitudes. Cumulative environmental effects will only be addressed in environmental assessments when they are considered to be sufficiently important, and this will require charges in prevailing cultural and social values and attitudes.

Unlike land use planning, however, environmental assessment does not include the establishment of any goals or criteria to judge the acceptability or otherwise of the proposed project. Indeed, it is not at all clear how regulators reach decisions on whether the environmental effects of a proposed project are acceptable or not. Often, environmental standards and guidelines are used, but these were not intended for this purpose and do not explicitly embody goals for ecosystem health.

**The Role of Proponents**

Another limitation is that project-specific environmental assessments are prepared by proponents and it may be unrealistic to expect them to assess the environmental effects of their projects in an unbiased manner. Of course, the proponent does not make the ultimate decision, but nevertheless regulatory agencies depend on the proponent for the information upon which to make decisions. In addition, the preparation of an environmental assessment can involve considerable time and expense, although assessment costs are usually a small proportion of total project costs.

**Scale**

As mentioned above, most environmental assessments focus on individual projects. Thus, they rarely contain a comprehensive overview of other activities in the area and the cumulative environmental effects they are causing. Indeed, it is probably not reasonable to expect proponents to do this. Project-specific environmental assessments focus on the effects of a single project. They do not usually consider the full ecosystem context of the project e.g., other resource users in the area and the pre-existing levels of stress in the ecosystem. This is an essential component of addressing cumulative environmental effects. This has been recognised by many people familiar with cumulative environmental effects. For example, at the U.S. - Canadian binational workshop on cumulative effects, Orians stated that:

> "the traditional methods of assessing the significance of development on a project-by-project basis may fail to predict and, hence, help us manage, cumulative environmental effects" (Orians, 1986).

To assess cumulative environmental effects, a holistic understanding of all of the stresses in an area over time is needed, together with an appreciation of what is necessary for a healthy ecosystem.

### 4.4 Ecosystem-Based Planning

Although land use planning and environmental assessment are important tools for environmental planning and management, in practice, neither is ideally suited to assess cumulative environmental effects. What is needed is an ecosystem-based planning process that would plan for the social, economic and biophysical components of the ecosystem by examining how alternative scenarios would protect and promote ecosystem health. It would:

- Use a holistic approach to address cun ılative environmental effects by:
  - Synthesising information and values in an ongoing, multistakeholder process;
  - Ensuring coordination and collaboration between different government departments and agencies;
- Establish goals and maximum acceptable levels of stress in the social, economic and biophysical ecosystems taking into account the interactions between them. It would also recognise that imposing 'limits to growth' may limit opportunities in some communities and not others, causing inequities (compensation may be required);
- Examine the current state of ecosystem health;
- Explore the nature and extent of human activities that are compatible with the protection and promotion of ecosystem health;
- Recognise that incremental decision-making is a major contributor to cumulative environmental effects and that multiple decisions about small projects are very important; and

- Ensure that the resulting plan is somewhat flexible, but rigid enough to implement its goals.

The fundamental purpose of ecosystem-based planning would be to reconcile current and future human uses of an area with the conditions necessary to promote and protect ecosystem health. Section 6 describes a framework for ecosystem-based planning that could be used in the Greater Toronto Bioregion in more detail.

5

# THE CONTEXT FOR ECOSYSTEM-BASED PLANNING IN THE GREATER TORONTO BIOREGION

## 5.1 The Region and Its Surroundings

The Greater Toronto Bioregion has been defined as the area bounded by the Niagara Escarpment to the west, the Oak Ridges Moraine to the north and east, and Lake Ontario to the south (Royal Commission on the Future of the Toronto Waterfront, 1990). The lands and waters of this bioregion share many climatic and ecological similarities. The soils and land forms are based on the glacial deposits of the Lake Ontario plain as it rises from the shores of the lake to the Oak Ridges Moraine. The watersheds arising in the moraine drain southwards to Lake Ontario and northwards to Lakes Simcoe and Scugog. Most of the bioregion is now within the commuter and economic orbit of Toronto.

Despite its climatic and ecological similarities, the region is relatively diverse. Although about 25 per cent of the region is covered by cities and towns, about 50 per cent can still be categorised as agricultural or rural. With the ongoing expansion of many suburban areas, however, much agricultural land continues to be lost to development. For example, between 1981 and 1986 about 8 per cent of the total agricultural acreage was lost.

Within the region, there are 16 major rivers flowing into Lake Ontario and approximately 65 river systems in the area. Although few, if any are in a totally natural state, they are still important feature of the ecosystem for humans and wildlife. In some cases, the river valleys have been converted into conservation areas or parks.

The Greater Toronto Bioregion is part of larger ecosystems, such as the Great Lakes Basin, and it, in turn, contains many small ecosystems, such as the Don River Watershed. All of these are interconnected and dependant on each other. Many of the activities in the Greater Toronto Bioregion affect ecosystems outside the region. For example, hazardous wastes are routinely trucked to Sarnia for treatment and disposal. Also, activities in the Greater Toronto Bioregion

can affect different ecosystems within the region to varying degrees. For example, household wastes from the region are disposed of at the Keele Valley landfill site. Similarly, activities outside the region can cause cumulative environmental effects inside it. For example, the long-range transportation of air pollutants from the U.S. and toxic chemicals transported by water from the Niagara River affect the Greater Toronto Bioregion.

Thus, the boundaries of the Greater Toronto Bioregion are not rigid, but are extremely permeable. Materials and energy flow between the region and its surroundings, as well as within it. The ecosystem concept is most useful in helping us think about the interactions and relationships occurring in a loosely defined area, rather than seeing the region as having fixed impermeable boundaries.

This report focuses on the assessment of cumulative environmental effects of activities that occur, and have effects in the Greater Toronto Bioregion. Although the effects of activities in the region could be experienced outside the region, it is likely that in many cases they will be experienced inside it. However, many of the ideas discussed in this report could be applied to assessing cumulative environmental effects in any region.

### 5.2 Cumulative Environmental Effects in the Region

The Institute for Research on Public Policy and the U.S. Conservation Foundation (1990), have categorised the types of stress that can affect ecosystems. In this section, their categorisation is used as a basis for describing cumulative environmental effects in the Greater Toronto Bioregion. It is intended to provide a broad overview, rather than being fully comprehensive. Conditions in specific areas of the region differ considerably, depending on their unique interactions and features. The five types of stresses identified by the Institute for Research on Public Policy and the U.S. Conservation Foundation are:

- Natural processes e.g., weather, fire and disease outbreaks;
- Physical restructuring e.g., dredging of harbours and draining of wetlands;

- Additions of materials and energy e.g., emissions of heat and persistent toxic chemicals;

- Removal of renewable and non-renewable resources e.g., withdrawal of surface or groundwater and fish harvesting; and

- Introduction of non-native species e.g., sea lamprey and zebra mussel.

All of these stresses are present in the Greater Toronto Bioregion and they are associated with many cumulative environmental effects. Some of the main influences are summarised below.

**Natural Processes**

The greatest natural process shaping the Greater Toronto Bioregion was the retreat of the Wisconsin Glaciers, starting about 15,000 years ago. The cumulative environmental effects of the glaciers are still with us, in the form of the physical landforms around us, including the river valleys, the Oak Ridges Moraine and the fertile soil of the area.

More recently, Hurricane Hazel served as a reminder of the power of natural processes. The Hurricane caused widespread flooding and property damage in Toronto as well as the loss of human life. Although most of these acute, time crowded cumulative environmental effects are now only memories, it could be argued that one of the most important effects has been the establishment of flood control policies and facilities in the Greater Toronto Bioregion. In addition, Hurricane Hazel is used as a basis for assessing certain flood events.

In addition to these dramatic natural events, it is important to take account of ongoing natural processes in the area, such as the region's climate and the lake's currents.

**Physical Restructuring**

Human activities have altered the physical form of the Greater Toronto Bioregion enormously. While many wetlands have been drained for farms, bulldozed for housing or infilled to provide

land for industrial or transportation uses, the shoreline of the lake itself has been altered by lakefilling. In Toronto, all of the land south of the Esplanade was created by lakefilling for port and transportation use and the Port Industrial Area is built on land reclaimed from the Ashbridges Bay Marsh. The Metropolitan Toronto and Region Conservation Authority has created four parks from lakefill and has plans to create two more. The cumulative environmental effects of the loss of wetlands and of lakefilling projects are only now becoming clear. These include positive effects, such as opportunities for housing, employment and recreational activities as well as negative effects, such as loss, alteration and fragmentation of habitats (although it can be argued that lakefilling also creates habitats), and changes in species diversity. Even the lake bottom has been altered by stonehooking (the collection of rock for building), increased sedimentation rates associated with erosion, and dredging activities.

As well as the restructuring of land/water interfaces, construction activities have dramatically changed the appearance of the region. The downtown Toronto skyline is filled with high rise towers, while at ground level the roads form a grid pattern over the entire region.

**Additions of Materials and Energy**

There are many examples of the cumulative environmental effects associated with the addition of materials and energy to the Greater Toronto Bioregion. A major concern is the discharge of persistent toxic chemicals in the Great Lakes Basin and the cumulative effects on wildlife and humans, in terms of residue levels in their tissues as well as effects on individual and population health. Persistent toxic chemicals have been detected in all ecosystem media including air, water, soil and biota. Information on the presence of contaminants in water and biota is relatively good, but we know less about the extent of soil and air contamination and the effects they cause.

Another example is the addition of nutrients, especially nitrogen and phosphorus, to the ecosystem. Approximately twenty years ago, phosphorus in Lake Erie, originating from detergents and fertilisers, was responsible for huge algal blooms that severely disrupted ecosystem health. Even now, Toronto's Inner Harbour borders on a eutrophic state, largely as a

result of nutrient inputs. Other important additions include waste heat (to air and water), emissions to the air from cars and industries and solid and liquid waste disposal.

**Removal of Renewable and Non-Renewable Resources**

The Greater Toronto Bioregion is rich in terms of natural resources. Natural resources that are removed from the ecosystem today include surface and groundwater, agricultural crops, fish and sand and gravel. Despite the region's abundance, many of the resources used in the region are imported from elsewhere. For example, most of the energy used in the region is imported, although some is generated at the Lakeview Generating Station in Etobicoke and the Pickering Nuclear Plant. These and other forms of energy production affect ecosystems outside the Greater Toronto Bioregion. Fossil fuel generating stations are sources of the gases that form acid rain and radioactive wastes from nuclear power stations will require indefinite containment in carefully sited and engineered waste disposal sites.

**Introduction of Non-Native Species**

Currently, the most important non-native species in the Greater Toronto Bioregion are probably sea lamprey, zebra mussels and purple loosestrife. There are many other introduced species that have apparently not disrupted ecosystem health, although they have not been studied. The sea lamprey has caused cumulative effects on fish populations, while the recently arrived zebra mussel threatens to clog many water intake pipes and may disrupt the existing food chain. Purple loosestrife, although attractive, may profoundly disrupt the ecological balance in the few remaining wetlands in the area.

In summary, natural processes and human activities have profound cumulative environmental effects on the Greater Toronto Bioregion. Human activities have probably affected every aspect of the region's ecosystem in some way. Not all of these effects are harmful to the ecosystem but it is clear that we have an obligation to manage the effects of our activities to the best of our abilities so they protect and enhance the health of the ecosystem of the Greater Toronto Bioregion.

## 5.3 Institutional and Jurisdictional Arrangements

All levels of government are involved in managing different aspects of the social, economic and biophysical ecosystems of the Greater Toronto Bioregion. The federal level of government has jurisdiction over navigation, shipping, fisheries, harbour activities, airport facilities and to some extent water quality. The federal Departments of the Environment, Fisheries and Oceans, Transport and Public Works all have interests in the Greater Toronto Bioregion. In addition, the Board of the Toronto Harbour Commissioners is an important body. It is responsible for a relatively large amount of land and for operating the Port of Toronto. The Royal Commission has made several recommendations regarding the Toronto Harbour Commissioners which would change its role and mandate.

At the provincial level, the Ontario Ministries of the Environment, Natural Resources and Municipal Affairs have responsibilities for the biophysical ecosystem. They administer several important Acts including the Planning Act, the Conservation Authorities Act, the Environmental Assessment Act and the Environmental Protection Act. In addition, the Ontario Ministries of the Environment and Natural Resources are responsible for programs that monitor the presence of contaminants in the environment. In 1988, the province established an Office for the Greater Toronto Area (GTA). The boundaries of the GTA are not quite the same as those of the Greater Toronto Bioregion. The office is intended to bring together the Province, the Regions and the local municipalities in the area to ensure that emerging needs are addressed and that plans do not conflict.

There are several regional governments in the Bioregion including Halton, Peel, York, Durham and Metropolitan Toronto. These regional municipalities establish overall planning strategies (under the provincial Planning Act) and are responsible for drinking water and wastewater treatment. They are also responsible for trunk sewers and for enforcing local sewer use by-laws. City governments, such as the City of Mississauga, the City of Toronto and the City of North York are responsible for detailed planning and zoning as well as administering the Building Code and other activities.

The Conservation Authorities, established under the provincial Conservation Authorities Act, have powers to develop, implement and coordinate watershed management plans. They are also responsible for fill regulations, flood control and for managing conservation areas.

There are also many non-governmental organisations that address environmental concerns. They include relatively large, groups that deal mainly with national issues, such as Pollution Probe and the Canadian Environmental Law Association, and small, local groups that focus on a single issue or area, such as Friends of the Spit.

In summary, the institutional and jurisdictional arrangements in the Greater Toronto Bioregion are complex. All levels of government are involved and within each level, there are often several departments or ministries with environmental planning or management responsibilities. This indicates that the procedural arrangements for ecosystem-based planning are also likely to be somewhat complex. Indeed, a high level of coordination and collaboration will be required between the players. Interactions and relationships in this 'organisational ecosystem' will be extremely important, just as it is now recognised that interactions and relationships are in biophysical, social and economic ecosystems are vital.

## 5.4 Environmental Planning and Management Activities in the Greater Toronto Bioregion

There are many environmental planning and management activities in the Greater Toronto Bioregion administered by different government departments. A list of some of the major activities is shown in Table 6.

The activities listed usually focus on a particular component of the ecosystem, e.g., water, air or land. Although several espouse an ecosystem approach, they are usually based on a single medium. For example, although the Great Lakes Water Quality Agreement commits the parties to an ecosystem approach, it is based on water quality considerations. It was only in the 1987 amendments, nine years after the adoption of an ecosystem approach, that sections on land and the atmosphere were added.

**TABLE 6: LIST OF SOME OF THE MAJOR ENVIRONMENTAL PLANNING AND MANAGEMENT ACTIVITIES IN THE GREATER TORONTO BIOREGION**

| PROGRAM, PLAN OR POLICY | JURISDICTION/ DEPARTMENT | AUTHORITY | PURPOSE |
|---|---|---|---|
| Great Lakes Water Quality Agreement | Governments of Canada and the U.S. | N/A | To restore and maintain the chemical, physical and biological integrity of the waters of the Great Lakes Basin |
| Lake Ontario Toxics Management Plan | Environment Canada | Great Lakes Water Quality Agreement | To restore Lake Ontario for human uses and for ecosystem health |
| Metro Toronto Remedial Action Plan | Ontario Ministry of the Environment/ Environment Canada | Great Lakes Water Quality Agreement | To remedy the environmental problems associated with the Metropolitan Toronto Waterfront, as well as rivers, creeks and their watersheds |
| Municipal - Industrial Strategy for Abatement | Ontario Ministry of the Environment | Environmental Protection Act | Virtual elimination of discharges of persistent toxic substances |
| Proposed Clean Air Program | Ontario Ministry of the Environment | Environmental Protection Act | To reduce loadings of contaminants to the atmosphere |
| Management of Fish Habitat | Federal Department of Fisheries and Oceans and the Ontario Ministry of Natural Resources | Fisheries Act | To increase the natural production capacity of fish habitat |

| | | | |
|---|---|---|---|
| Space for All: Options for a Greater Toronto Area Greenlands Strategy | Ontario Ministry of Natural Resources | N/A | To identify areas for a greenlands systems; examine methods to secure them and to explore possible institutional arrangements |
| Niagara Escarpment Plan | Niagara Escarpment Commission | Niagara Escarpment Planning and Development Act | To protect the Niagara Escarpment and land in its vicinity. Development should be compatible with the natural environment |
| Oak Ridge Moraine Strategy (proposed) | Ontario Ministry of Natural Resources | Planning Act | To develop a long term strategy for the protection and management of the Oak Ridges Moraine |
| A Framework for Ecosystem Planning: An Innovative Approach to Watershed Management (draft) | Metropolitan Toronto Region Conservation Authority | Conservation Authorities Act | To propose a new approach to the planning and management of the physical, biological and human environment |
| Various Initiatives | Ontario Ministry of Municipal Affairs | Planning Act | To include environmental considerations in municipal planning |
| Environmental Assessment Program Improvement Project | Ontario Ministry of the Environment | Environmental Assessment Act | To reform the Environmental Assessment Act and improve the process of environmental assessment in Ontario |

| | | | |
|---|---|---|---|
| The Greenspace Plan for the Greater Toronto Area | Metropolitan Toronto and Region Conservation Authority | Conservation Authorities Act | To manage urban growth and preserve greenspace |

Note: Activities in local municipalities are too numerous to be included.

Environmental planning activities do not, in general, have monitoring programs associated with them, making it difficult to evaluate their implementation. In contrast, most of the environmental management activities have both a plan and a monitoring component. However, the plans have not been systematically linked to the environmental planning activities. Monitoring programs are discussed in the next section.

Some of the activities listed in Table 6 were designed to address cumulative environmental effects specifically. For example, the Niagara Escarpment Plan states that:

> "The cumulative impacts of development will not have serious detrimental effects on the Escarpment environment (e.g., water quality, vegetation and landscape)."

## 5.5 Information on Ecosystem Quality in the Greater Toronto Bioregion

In comparison with other parts of Canada, there is a relatively large amount of information on the biophysical components of the ecosystem in the Greater Toronto Bioregion. The region has been studied extensively, particularly in the last ten years or so, partly because of the severity of the environmental problems and partly because of the increasing number of residents. Scientific data are collected either in monitoring or research programs. Monitoring programs measure the same parameters or indicators repeatedly and consistently over time and/or distance so that valid temporal and/or spatial trends can be established. Research programs are usually developed to test an idea or to investigate a particular problem. In addition to scientific data, anecdotal and community information can provide useful information.

Until recently, most scientific studies focused on measuring levels of various parameters, such as PCBs, suspended solids and BOD, in environmental media. Thus, there is a relatively large database on levels of parameters in the biophysical ecosystem. This includes levels of persistent toxic chemicals in human and animal and fish tissues. There is much less information available on the biological significance of these levels, i.e., information on the effects in biota. Effects can be experienced at many different levels, from the sub-cellular to the population level. It is only now that monitoring and research programs are focusing on biological effects. Effects include enzyme induction, egg shell thinning, congenital anomalies (e.g., crossed bills and leg

deformities in birds and reduced reproductive success).

Although 'effects' monitoring is a relatively new development, there are several monitoring programs in the Greater Toronto Bioregion from which regional ecosystem health can be deduced. These are outlined in Table 7. None of these programs was explicitly designed to monitor for cumulative environmental effects, however, information from them can be used to establish the current state of the ecosystem.

**TABLE 7: SOME OF THE MONITORING PROGRAMS IN THE GREATER TORONTO BIOREGION THAT CAN BE USED TO DEDUCE ECOSYSTEM HEALTH**

| PROGRAM | RESPONSIBLE ORGANISATION | SUMMARY |
|---|---|---|
| Herring Gull Program | Canadian Wildlife Service, Environment Canada | Assesses spatial and temporal trends of selected contaminants in eggs of herring gulls from the Great Lakes Basin |
| Nearshore Juvenile Fish Contaminants Surveillance Program | Ontario Ministry of the Environment | Assesses contaminant uptake in young-of-the-year spottail shiners as a function of time and location |
| Sport Fish Contaminant Monitoring Program | Ontario Ministry of the Environment | Monitors concentrations of contaminants in sport fish to generate the Annual 'Guide to Eating Ontario Sport Fish' |
| Water/Sediment Quality in Toronto Nearshore | Ontario Ministry of the Environment | Provides information on physical and chemical characteristics of sediment and water |
| Lakefill Monitoring Program | Metropolitan Toronto and Region Conservation Authority | Assesses effects of lakefilling on water and sediment quality and biota |
| Air Quality Index | Ontario Ministry of the Environment | Provides information to the public on air quality on a daily basis |
| Atlases of Birds (published) and Mammals (in preparation) Reptiles | University of Waterloo, Federation of Ontario Naturalists, Ontario Federation of Anglers and Hunters, the Ontario Ministry of Natural Resources and others | To record the historical and current distribution of birds, mammals, reptiles and amphibians in Ontario |
| Recreational Water Quality | Local Health Units | Determines levels of microbiological agents at swimming beaches |

Note: In addition, the Conservation Authorities conduct several smaller site-specific environmental monitoring programs, such as the one associated with the disposal of dredgeate at the Eastern Headland.

6

## A PROPOSED FRAMEWORK FOR ECOSYSTEM-BASED PLANNING IN THE GREATER TORONTO BIOREGION

This section outlines a proposed framework for ecosystem-based planning that could be used in the Greater Toronto Bioregion. This framework could also be applied to other regions. However, the need for ecosystem-based planning in the Greater Toronto Bioregion is probably greater than in many other regions of the country because of the nature and extent of the existing cumulative environmental effects, the rapid rate of development and change in the area and because of the large number of government agencies and departments that have responsibilities for environmental planning and management activities.

The concept of 'ecosystem-based planning' is not new in the Greater Toronto Bioregion. For example, in 1990 the Metropolitan Toronto and Region Conservation Authority held five workshops to assist in the development of watershed management strategies and in planning for the Seaton Community in Pickering. The product of these workshops is a draft report entitled "A Framework for Ecosystem-based Planning: An Innovative Approach to Watershed Management" (Metropolitan Toronto and Region Conservation Authority, 1990). In addition, the Ontario Ministry of Municipal Affairs is working on several initiatives to improve the integration of environmental considerations in the municipal planning process.

This framework was deliberately developed independent of the provisions of existing legislation, such as the Planning Act and the Environmental Assessment Act. A range of approaches could be used to implement the framework: using existing legislation without modifying it, making minor changes to existing laws, or fundamentally changing legislation.

The proposed framework outlined in this report is composed of several activities. These are:

- Scoping;
- Establishing goals and maximum acceptable levels of ecosystem stress as well as the 'valued characteristics' to be used in the planning process;

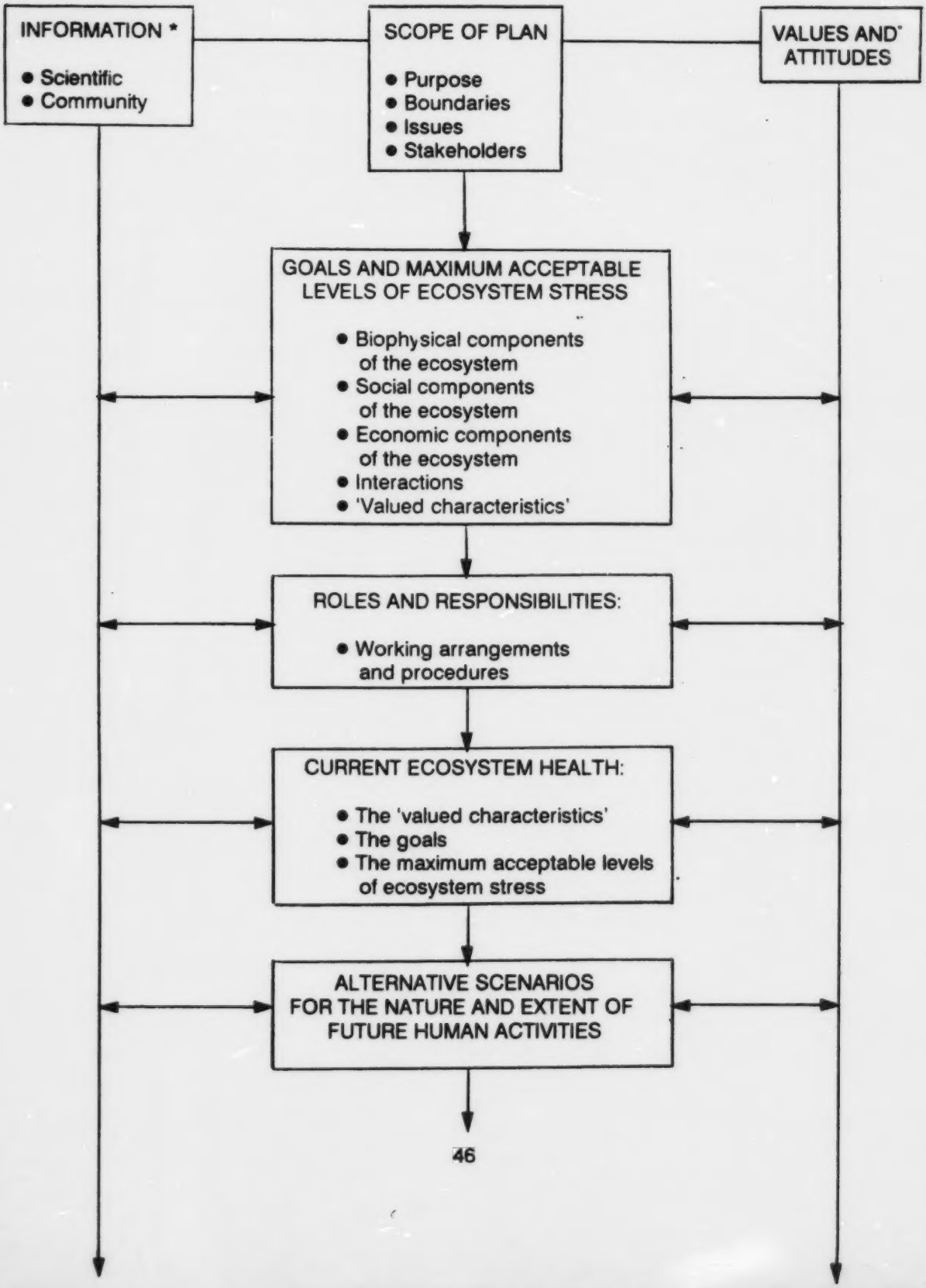
- Defining roles, responsibilities and working arrangements;
- Assessing current ecosystem health;
- Identifying alternative scenarios;
- Predicting the cumulative environmental effects of the alternatives;
- Deciding on the preferred scenario;
- Developing performance-based requirements for projects and a monitoring program;
- Establishing implementation arrangements; and
- Evaluating and revising the plan.

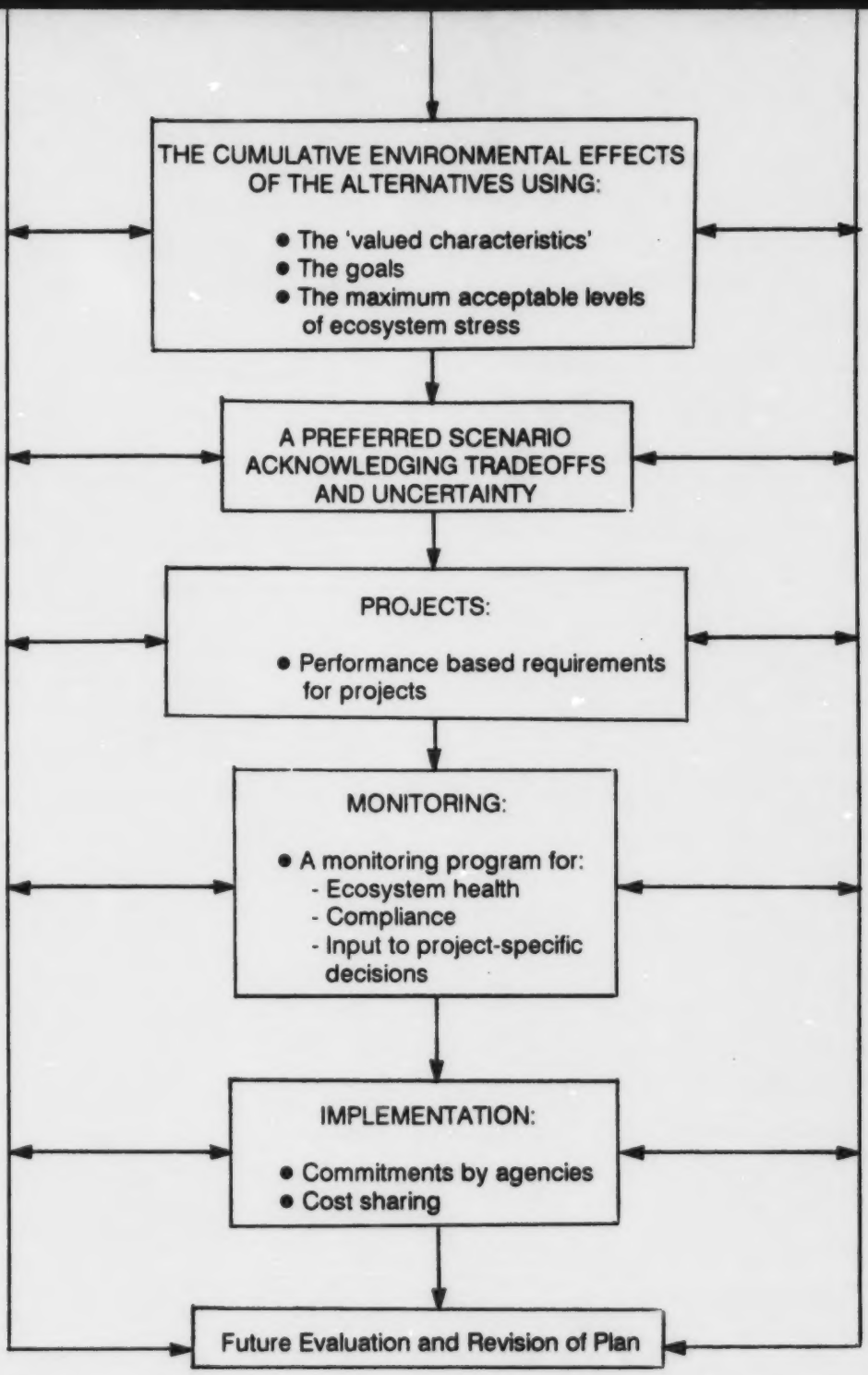
Each of these activities is described below and the proposed framework is shown in Figure 1. In some cases, such as the scoping, activities should be seen as ongoing throughout the planning process. Thus, to some extent it is an iterative, rather than a sequential process. Although it is shown as a linear process, different activities feed back and feed into others. For example, it may become necessary to change or refine the roles and responsibilities at any stage of the process.

### 6.1 Scoping

The initial step in the proposed framework is scoping. It involves clarifying why the plan is necessary. In many cases, the purpose may focus on gaining a better understanding of an area as well as how it is, and will be, affected by human activities.

**FIGURE 1: PROPOSED FRAMEWORK FOR ECOSYSTEM-BASED PLANNING**


INFORMATION *
• Scientific
• Community
SCOPE OF PLAN
• Purpose
• Boundaries
• Issues
• Stakeholders
VALUES AND ATTITUDES
GOALS AND MAXIMUM ACCEPTABLE LEVELS OF ECOSYSTEM STRESS
• Biophysical components of the ecosystem
• Social components of the ecosystem
• Economic components of the ecosystem
• Interactions
• 'Valued characteristics'
ROLES AND RESPONSIBILITIES:
• Working arrangements and procedures
CURRENT ECOSYSTEM HEALTH:
• The 'valued characteristics'
• The goals
• The maximum acceptable levels of ecosystem stress
ALTERNATIVE SCENARIOS FOR THE NATURE AND EXTENT OF FUTURE HUMAN ACTIVITIES


THE CUMULATIVE ENVIRONMENTAL EFFECTS OF THE ALTERNATIVES USING:
• The 'valued characteristics'
• The goals
• The maximum acceptable levels of ecosystem stress
A PREFERRED SCENARIO ACKNOWLEDGING TRADEOFFS AND UNCERTAINTY
PROJECTS:
• Performance based requirements for projects
MONITORING:
• A monitoring program for:
- Ecosystem health
- Compliance
- Input to project-specific decisions
IMPLEMENTATION:
• Commitments by agencies
• Cost sharing
Future Evaluation and Revision of Plan

* Requires ongoing, open multistakeholder participation

Another scoping activity is to establish the temporal and spatial boundaries within which the plan will apply. These include temporal and spatial boundaries for current and possible future human activities and for their cumulative environmental effects. Often, the boundaries of human activities will be quite different from those of the cumulative environmental effects. For example, the effects of an activity may manifest themselves at locations far removed from the activity itself, such as acid rain falling many hundreds of miles away from fossil fuel generating stations that produced the acidic chemicals involved. It then becomes difficult to identify the cause(s) of the effects, let alone their interactions with other activities and the ecosystems within which they occur. Similarly, cumulative environmental effects often occur in much longer time frames than the activities that caused them. For example, the cumulative environmental effects of development in the upper reaches of a watershed are still a problem downstream long after the development occurred. It is probably impossible to ascertain the eventual cumulative environmental effects precisely because future conditions are uncertain. The longer the time frame used, the more uncertainty is involved. In addition, some cumulative environmental effects tend to accumulate over time, while others dissipate. For some, there may be a threshold or trigger, below which effects dissipate, but above which they accumulate. For example, there is evidence that at low levels of exposure to many chemicals, cells can repair any damage to their DNA. However, there are thresholds, above which the repair mechanisms cannot cope with the damage, and effects occur. Thus, it is important to understand how different systems respond to different stresses.

No matter what temporal or spatial boundaries are set, the planning process should consider the relationships of the selected area to its surroundings. The selected area will inevitably influence its surroundings, just as it will be influenced by its surroundings. Therefore, all boundaries are 'fuzzy' and it will be important to consider the spatial context of the defined region.

During scoping it is also important to identify the key issues that will be discussed in the planning process. This includes the types of human activities already in the area as well as their cumulative environmental effects. Scoping these issues is the natural prelude to assessing current ecosystem health.

In addition, relevant concepts should be clarified. For example, do the people and organisations who have shown an interest have different concepts or values that are relevant to the planning process (e.g., different concepts of the ecosystem, different understandings of the importance of different cumulative environmental effects), or are they similar? For example, concepts of the environment may be quite different in different cultures. Given Toronto's multicultural nature, it may be important to discuss and clarify these concepts early on in the planning process. During the scoping stage it is also important to identify the 'stakeholders' and have preliminary meetings and discussions with them to ascertain their level of interest, to assist in the identification of the major human activities and effects and to clarify the context of the assessment. Many of the stakeholders are likely to live or work in the study area, but because activities in the area will have cumulative environmental effects outside its boundaries, the stakeholders will include people from elsewhere. Stakeholders also include future generations and non-human species. One way of defining the stakeholders is to identify who is likely to benefit from activities in the area, and who is likely to experience negative effects, such as increased traffic, perceived or actual exposure to persistent toxic chemicals and increased stress on community facilities. The stakeholders that benefit may be different from those that experience negative effects.

### 6.2 Establishing Goals and Maximum Acceptable Levels of Ecosystem Stress

Establishing goals, policies, objectives or criteria to judge the acceptability of the alternative scenarios is an essential step. This process should involve reviewing existing goals for the area, whether they are explicitly stated in a document or report or implicit in communities, government departments etc. In many cases, the goals for an area are likely to be conflicting. For example, economic development goals may not be compatible with goals for conservation and preservation of heritage. In addition, there may be goals for different levels of activity that may be conflicting. For example, the objectives of a development project may not be compatible with a regional habitat protection policy.

Once existing goals, policies and objectives have been reviewed, specific ones can be established to be used in the plan. New goals, policies or objectives can be developed, or existing ones used. When establishing these guiding principles, it will be important to consider if

they should be visionary (e.g., zero discharge of persistent toxic substances) or more pragmatic (e.g., best available technology), or a mixture. Since the planning process is based on a holistic approach, the goals, principles or policies should include social, economic and biophysical considerations, as well as the interactions between them. Criteria for biophysical, social and economical sustainability may provide a suitable framework. One set of goals that may be especially helpful is the goals developed by the Metro Toronto Remedial Action Plan Public Advisory Committee. Although they focus on the aquatic ecosystem, they combine biophysical, social and economic considerations. Of course, most planning processes already take biophysical, social and economic consideration into account, b;ut often the interactions among them are not fully examined.

As well as establishing ecosystem goals, it will also be necessary to determine the maximum acceptable levels of ecosystem stress on the ecosystems. These levels are likely to be qualitative, rather than quantitative, although existing environmental standards and guidelines established by the federal and provincial governments may help. It is often difficult to define such levels until an assessment of ecosystem health has been conducted. In many cases, it is difficult to know in advance how much stress is too much. It is usually easier to know when an ecosystem is over-stressed than it is to predict how much is enough. For example, it is obvious that Hamilton Harbour has exceeded any maximum acceptable levels of stress, but it would have been difficult to identify acceptable levels of disruption in advance.

Despite the difficult of establishing acceptable levels of ecosystem stress, attempts should be made to do so. The levels should be based on scientific and community information and values and attitudes. In many cases, it may be necessary to use information from outside the planning area, such as toxicological data on levels of chemicals that cause effects in wildlife populations. However the maximum acceptable levels are derived, they should be developed for the biophysical, social and economic components of the ecosystem, and the interactions among them.

It will also be necessary to define the valued economic, social or biophysical characteristics of the area and how they can be measured. This should include the desirable characteristics from a human perspective, such as a diverse economy and opportunities for a variety of activities

(recreation, working, living), as well as those from the perspective of ecosystem health, such as the presence of abundant, diverse, high quality and non-fragmented habitat. The identification of the 'valued characteristics' may emerge from discussions of the goals to be used in the planning process, as discussed in the section on scoping, or vice versa. After the 'valued characteristics' have been identified, it will be necessary to decide how they can be measured or determined. In some cases, there may be indicators that can be used. For example, if the availability of recreational opportunities is a 'valued characteristic', then indicators might be the availability of boating and swimming facilities. It may also be necessary to define specific parameters that can be measured for the indicators. For example, if the indicators are the availability of boating and swimming facilities, the parameters to be measured could be the number of occupied boat slips at each marina or the number of swimmers or the frequency of swimming. The intention of this step is to establish how the health of the area will be measured. One example of the development of a set of 'valued characteristics' is the criteria for ecosystem health that are used in Pathways, the Royal Commission's final report on the Environmental Audit of the East Bayfront/Port Industrial Area.

It could be argued that it would be difficult to establish goals, acceptable levels of ecosystem stress and the 'valued characteristics' before the state of the ecosystem's health has been assessed. Nevertheless, it will be helpful to understand what indicators are likely to be the most important in the assessment before it is conducted. They will be those related to the 'valued characteristics'. Equally, it will be helpful to understand how the information form the indicators will be evaluated, to determine ecosystem health i.e., by comparing it to the goals and acceptable levels of ecosystem stress.

### 6.3 Defining Roles and Responsibilities

Defining the roles and responsibilities of the stakeholders in the planning process will naturally follow the identification of the stakeholders, as discussed in the earlier section on scoping. Indeed, defining the roles and responsibilities of the stakeholders could start during scoping, although it cannot be finalised until after the goals have been established. It may involve different government departments or agencies at different levels (e.g., municipal, provincial, federal), proponents, developers or private industry, public interest or community groups,

interested individuals and academics. In some cases, it may be appropriate to formalise agreed-upon roles and responsibilities in memoranda or letters of understanding or contracts, particularly if staff or financial resources are involved. While roles and responsibilities are being clarified, it is also helpful to decide on the working procedures and arrangements to be used in the planning process. How is information going to be managed and by whom? How will the stakeholders work together? For example, will there be a coordinating committee, or an advisory/review committee? Once again, in some cases it may be helpful to formalise these procedures and arrangements in writing, such as in terms of reference for committees. Roles and responsibilities may well change during the planning process. Thus, this activity is not separate from the others outlined in this proposed framework. It will be important to discuss the appropriateness of roles and responsibilities throughout the planning process.

Whatever roles, responsibilities and procedures are agreed on, it will be important to bear in mind that:

> "The assessment of cumulative effects directly challenges.....entrenched practices, jurisdictions, and value systems, and so will not easily be accommodated within established mechanisms" (Roots, 1986).

Generally, the more complex and fragmented the roles and responsibilities of different agencies, the more difficult it will be to define roles, responsibilities and procedures. The institutional, jurisdictional and procedural issues are less when an agency or department has complete control of the land or project under consideration. For example, it is easier for a Conservation Authority to assess and manage the cumulative environmental effects occurring in a conservation area than it is for it to assess and manage the cumulative environmental effects of a project for which it is only partially responsible, such as the implementation of a watershed plan.

### 6.4 Assessing Current Ecosystem Health

Assessing the current status of ecosystem health involves collecting all of the pre-existing relevant information on the social, economic and biophysical aspects of the area being studied.

This information may be scientific or community-based. It will then be necessary to synthesise the information into a 'state of the environment' report, or its equivalent so that an overview of the area can be constructed. Several municipalities, such as the City of Toronto have already prepared 'state of the environment' reports. GIS or other information management systems may be helpful.

Synthesising information is not easy and raises many issues including:

- The comparability of different databases and different types of data and information;
- Quality assurance/quality control;
- The use of different parameters or indicators;
- Dealing with equivocal conflicting or negative information; and
- Dealing with information gaps.

From the synthesis, it should be possible to identify data or information gaps. In some cases, there may be opportunities to fill these gaps by generating new information through monitoring programs or research. In others, the uncertainties associated with shortages of information will have to be accommodated in the assessment. Within the time frames of most decision-making processes, it is usually very difficult to plan, conduct and evaluate new monitoring programs. Often, it is necessary to use data from other sources that were not originally intended to monitor cumulative environmental effects.

In some cases, relationships, trends, patterns or associations between different aspects or components of the area will be obvious, such as the relationship between wildlife habitat and species diversity, while in others they may be less apparent. The main difficulty with establishing relationships and associations is that ecosystems consist of many interacting components that are mutually dependent on each other. Human activities can perturb these interactions,

producing a ripple effect throughout an entire system, making it difficult, if not impossible, to establish causality. Cumulative environmental effects are frequently non-specific and indirect, such as the effects of persistent toxic chemicals in the water of the Great Lakes on population sizes of fish eating birds. To deal with this problem, we need to move beyond linear cause and effect models of environmental change towards concepts of indirect and multiple causality ("webs of causality"), where associations, trends and patterns are as important as proving that a particular activity caused a specific environmental effect. For example, the only proven case where exposure to a persistent toxic chemical in the Great Lakes Basin "caused" reproductive failure is DDE-induced eggshell thinning in cormorants. Yet many scientists now accept that persistent toxic chemicals have caused health effects in many populations of biota and wildlife. This conceptual shift is one of the key challenges in understanding cumulative environmental effects.

### 6.5 Identifying Alternative Scenarios

In this step, alternative scenarios would be developed for the study area. In some cases, developers and resource users may already have scenarios that could be used. In others, it may be necessary to consider what resources in the area are likely to be further developed, how human settlements are likely to change over time or the sorts of opportunities that could be explored for recreation and tourism. In any event, it is probably necessary to limit the number of alternative scenarios to no more than four. If many more than four scenarios are selected, the planning process will become unwieldy. One of these could be a 'business as usual' scenario (i.e., no new initiatives). Part of identifying alternative scenarios will be to estimate the costs and other implications associated with each alternative. Obviously, any scenarios must be economically feasible i.e., be economically sustainable, although whether a scenario is economically feasible will be a value judgement itself.

### 6.6 Predicting the Cumulative Environmental Effects of the Alternative Scenarios

Predicting the cumulative environmental effects associated with proposed projects or activities could take many forms. Where the information is mostly quantitative, it may be possible to use mathematical modelling, but when it is mainly qualitative, best professional judgement may be

more appropriate. Specific methods are summarised in Appendix 2. In some cases, information from outside the study region, where similar projects or activities are already in place, may be helpful although extrapolating information should always be done cautiously. If possible, the 'margins of errors' for the prediction should be described. As in the baseline phase, it is necessary to be aware of any relationships, trends, patterns or associations, even between apparently unrelated occurrences.

### 6.7 Deciding on the Preferred Alternative

Decisions on the preferred alternatives are often made by an elected body, such as a council. However, in many instances, they can be appealed to appointed bodies, such as the Ontario Municipal Board or the Environmental Assessment Board. Thus, they are not usually made by the person or group that conducted the planning process.

Given that every alternative scenario is likely to have residual cumulative environmental effects, it is necessary to judge the acceptability of these effects compared to the benefits that are likely to result. Thus, the essence of decision-making is compromise. While each decision is different and will depend on prevailing socio-political and economic considerations, as well as biophysical ones, there are some general points that can be made, including:

- Often, the more uncertainty that is associated with predictions, the harder it is to make a decision. However, uncertainty cannot be used as a delaying tactic indefinitely. The biophysical, social and economic costs of inaction may also be considerable;

- Is the recommended course of action likely to achieve any or all of the goals and principles established in the planning process? Which alternative meets them best?

- Decision-making about the acceptability of alternative scenarios inevitably involves trade-offs. These can be between goals and principles (e.g., environmental protection as compared to economic development), between local

adverse effects as compared to the 'good' of the entire region or between social, economic and biophysical considerations (e.g., improving human health at the expense of ecosystem health). There may be other important inputs to decision-making.

The extent to which these and other general points are relevant in individual assessments will, of course, depend on the specific circumstances.

### 6.8 Developing Performance-Based Requirements for Projects and a Monitoring Program

After a decision has been made and the plan completed it should be implemented through performance-based requirements. A key consideration will be developing performance requirements for projects. Performance requirements would describe how individual projects would be expected to comply with the goals of the plan. They could include requirements for green space, energy conservation, facilities for recycling and waste separation, health and social facilities for employees and residents, day care facilities etc. While performance standards should be rigid enough to implement the plan, they should also be sufficiently flexible to allow adaptation to local needs and circumstances, as well as encouraging creativity and innovation.

It will also be necessary to develop a monitoring program to assess the implementation of the plan. The monitoring program should have three general objectives:

- To assess spatial and temporal changes in ecosystem health;
- To ensure compliance with the plan's goals and with any relevant standards and guidelines; and
- To provide information that can be used in making decisions about individual projects.

Ideally, the monitoring program should address the social, economic and biophysical ecosystems and use the 'valued characteristics' identified in the plan. It will be important to consider who will be responsible to the monitoring program and what the ongoing mechanisms for providing information to the stakeholders will be.

It can be argued that work on developing performance requirements and a monitoring program should commence before a decision has been made on the preferred alternative. To date, implementation mechanisms for land use plans and environmental assessments have been partly left up to the developer or proponent and there has been little, if any, monitoring of the implementation of development agreements. To ensure that these activities do not get ignored in the future, work on them should start as early as possible, probably when staff have identified a recommended scenario, but before a decision has been made. Obviously, it will not be possible to finalise performance requirements or a monitoring program until a decision has been made.

### 6.9 Establishing Implementation Arrangements

Possible arrangements and mechanisms for implementation include municipal Official Plans (regional and local municipalities), watershed plans (Conservation Authorities), and the establishment of new agencies similar to the Niagara Escarpment Commission. Whatever arrangements and mechanisms are chosen, it will be vital to secure commitments from the agency(ies) or department(s) involved. The multistakeholder group should also clarify any cost-sharing arrangements.

### 6.10 Future Evaluation and Revision of Plan

Unlike environmental assessments, land use plans are occasionally revised. Evaluation and revision should be important components of environmental planning and management activities, so that they can take account of changing needs and circumstances. Thus, ecosystem plans should be periodically evaluated and revised to incorporate changes in the biophysical, social and economic ecosystems. The results from the monitoring program should be helpful in evaluating to what extent the plan's goals have been achieved.

### 6.11 Concluding Remarks on the Proposed Framework

There are many challenges associated with translating the concept of cumulative environmental effects into action. Some of the major challenges are described in the proposed framework. This framework is only one way of applying the concept of cumulative environmental effects to environmental planning and decision-making, and it is likely that others will be developed. But, although there are many specific issues that must be addressed in any assessment of cumulative environmental effects (e.g., setting boundaries and deciding on maximum acceptable levels of ecosystem stress), probably the largest single issue is the need for education. As mentioned previously in this report, the concept of cumulative environmental effects represents a new way of looking at the ecosystems around us. The fundamental challenge in applying any framework for ecosystem-based planning that takes into account cumulative environmental effects will be for all stakeholders to appreciate the complexity and subtlety of the relationships in ecosystems and to understand the implications of these relationships for existing and future human activities. This will require research and a lot of education.

The process proposed in this section has many similarities to land use planning and environmental assessment but it differs from them in several important ways. First, it differs from traditional land use planning in that it explicitly takes account of the biophysical components of ecosystems and the ways in which they interact with the social and economic components of ecosystems. Second, it differs from environmental assessment in that it establishes goals and maximum acceptable limits of stress that are used to judge the acceptability, or otherwise, of the cumulative environmental effects associated with the alternative scenarios. In addition, it emphasises a holistic, contextual understanding of the ecosystems in which current and future human activities occur.

The proposed framework is not intended to replace either environmental assessment or land use planning, but rather to make them more effective. For example, limited environmental assessments could be required for projects that were part of the preferred scenario. These could focus on such matters as any site-specific issues that would not have been examined in

the planning process. In contrast, more comprehensive environmental assessments could be required for projects that were not part of the preferred scenario, or whose goals were not compatible with those developed in the planning process.

The proposed framework could probably be integrated into environmental planning and management processes in the Greater Toronto Bioregion if the government departments and agencies involved agreed to do so. The Ontario Ministry of Municipal Affairs or the Office of the GTA could take a leadership role in promoting the concept and application of ecosystem-based planning. In addition, the Conservation Authorities could implement ecosystem-based planning on a watershed basis. The Metropolitan Toronto and Region Conservation Authority has already developed such a process (Metropolitan Toronto and Region Conservation Authority, 1990). Indeed, Conservation Authorities may be well-suited to do this because their boundaries are based on natural features.

No matter which government agency or department took the lead role, legislative, policy and procedural amendments would probably be required to implement the proposed framework. The Royal Commission workgroup on integrating environmental considerations in land-use planning is examining the legislative, policy and procedural changes that would be required (Royal Commission on the Future of the Toronto Waterfront, 1991). In addition, there would be significant resource implications (personnel and financial) for municipalities and agencies. However, the benefits would far outweigh these 'costs' and the implementation of such a process would represent a demonstration of the concept of 'anticipate and prevent'.

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# CONCLUSIONS

There are several conclusions that can be drawn from this report including:

1. Cumulative environmental effects are not addressed in environmental planning and management activities in the Greater Toronto Bioregion, although there is a growing awareness of the need to do so.

2. There are many human activities that have cumulative environmental effects in the Greater Toronto Bioregion. These include physical restructuring of the landscape, additions of material or energy, the removal of renewable and non-renewable resources and the introduction of non-native species.

3. There are many environmental planning, management and monitoring activities in the region that could be used to address cumulative environmental effects.

4. Cumulative environmental effects can be best addressed when plans are being developed for an area or region. They can only be addressed effectively at the project-specific level if they have been first included at this larger level.

5. Two of the most important environmental planning and management processes in the Greater Toronto Bioregion are those established under the Planning Act and the Environmental Assessment Act. As they are currently practised, neither is ideally suited to address cumulative environmental effects.

6. An ecosystem-based planning process is needed that takes into account the social, economic and biophysical components of the ecosystem and the interactions among them by considering how alternative scenarios would promote and protect ecosystem health. Such an ecosystem-based planning process would:

- Use a holistic approach to address cumulative environmental effects by:

  - Synthesising information and values in an ongoing, multistakeholder process;

  - Ensuring coordination and collaboration between different government departments and agencies ;

- Establish goals and maximum acceptable levels of stress in the social, economic and biophysical components of the ecosystem taking into account the interactions among them. It would also recognise that imposing 'limits to growth' may limit opportunities in some communities and not others, causing inequities (compensation may be required);

- Examine the current state of ecosystem health;

- Explore the nature and extent of human activities that are compatible with the protection and promotion of ecosystem health;

- Recognise that incremental decision-making is a major contributor to cumulative environmental effects and that multiple decisions about small projects are very important; and

- Ensure that the resulting plan is somewhat flexible, but rigid enough to implement its goals.

7. A framework for ecosystem-based planning could consists of:

- Scoping (purpose, boundaries, issues and stakeholder);

- Establishing goals and maximum acceptable levels of ecosystem stress (biophysical, social, economic);

- Defining roles, responsibilities and procedures and 'valued characteristics' to be used in the planning process;

- Assessing current ecosystem health in terms of measuring the 'valued characteristics' against the goals and the maximum acceptable levels of stress;

- Identifying alternative scenarios for the nature and extent of future human activities;

- Predicting the effects of the alternative scenarios on the 'valued characteristics' using the goals and maximum acceptable levels of stress;

- Deciding on the preferred alternative (taking into account tradeoffs and uncertainty);

- Developing operational requirements to implement the preferred alternatives and a monitoring program to determine ecosystem health on an ongoing basis, to assess compliance with the plan's goals and to provide information to project-specific decisions and to evaluate and revise the plan.

Several of these steps, especially scoping, should be regarded as ongoing activities throughout the planning process.

8. An ecosystem-based planning process, such as that outlined in this report, could be integrated into environmental planning and management processes in the Greater Toronto Bioregion, but legislative, policy and procedural amendments would probably be required. In addition, there would be significant resource (personnel and financial) implications for municipalities and agencies. However, the benefits would far outweigh these 'costs' and the implementation of such a process would represent a demonstration of the concept of 'anticipate and prevent'.

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## APPENDIX

## LIST OF WORKSHOP PARTICIPANTS

Suzanne Barrett
Royal Commission on the Future of the Toronto Waterfront

Beth Benson
City of Toronto

Dirk Blyleven
City of Mississauga

Brian Buckles
Pickering Rural Association

David Carter
Royal Commission on the Future of the Toronto Waterfront

Kate Davies
Ecosystems Consulting Inc.

Ron Doering
Royal Commission on the Future of the Toronto Waterfront

Tom Farrell
Ontario Ministry of Natural Resources

Adele Freeman
Metropolitan Toronto and Region Conservation Authority

Andy Hamilton
Rawson Academy of Aquatic Sciences

Glen Harrington
Conservation Council of Ontario

Mike Jerrett
Ontario Ministry of the Environment

Sarah Kalff
Royal Commission on the Future of the Toronto Waterfront

Ron Kanter
Shoreline Regeneration Workgroup of the Royal Commission on the Future of the Toronto Waterfront

Ron Kennedy
Ontario Ministry of Municipal Affairs

Joanna Kidd
Land Use Research Associates

Soo Kim
Royal Commission on the Future of the Toronto Waterfront

John Kinkead
Ontario Ministry of the Environment

Karen Partenan
King Township

Glenn Miller
Municipality of Metropolitan Toronto

John Maher
Metro Toronto Remedial Action Plan

Brian Nixon
Ontario Ministry of Municipal Affairs

Debbie Ramsay
Niagara Escarpment Commission

Ray Rivers
Environment Canada

Keith Rodgers
Hamilton Remedial Action Plan

Todd Salter
Caledon Township

Anna Shumeko
Environment Canada

Liz Stanley
Ontario Ministry of the Environment

Ben Vanderbrug
Hamilton and Region Conservation

Debbie Williams
Royal Commission of the Future of the Toronto Waterfront

# ANNEX

# SOURCES OF INFORMATION ON CUMULATIVE ENVIRONMENTAL EFFECTS

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## LIST OF INDIVIDUALS AND ORGANISATIONS
## FAMILIAR WITH CUMULATIVE ENVIRONMENTAL EFFECTS

To provide further information to the reader, the status or role of the individuals listed has been shown as follows:

RE = Researcher
R/A = Regulator or Administrator
P = Proponent
C = Consultant
PI = Public Interest

Bill Aird
Environmental Directorate
Indian and Northern Affairs Canada
Les Terrasses de la Chaudiere,
18th Floor
10 Wellington Street
Hull, Quebec
K1A 0H4

Tel: 997-0773
Fax: 953-1885
**R/A**

John Armstrong
U.S. Environmental Protection Agency
Region 10
Mail Stop WD 139
Seattle, Washington 98101

Tel: (206) 553-0165
Fax: (206) 553-1368

Bob Baker
Environmental Assessment Division
Environment Canada
351 St. Joseph Boulevard
Hull, Quebec
K1A 0H3

Tel: (819) 953-1693
Fax: (819) 953-4093
**R/A**

Judi Allen
Parks Canada
Natural Resources Branch
Les Terrasses de la Chaudiere
2nd Floor
Hull, Quebec K1A OH3

Tel: (819) 994-5533
Fax: (819) 994-5140
**P, R/A, RE**

Mark B. Bain
Assistant Leader for Aquatic Resources
331 Funchess Hall
Auburn University
Auburn, AL.
36849

Tel: (205) 844-9119 or 844-4796
Fax: (205) 844-9208
**RE**

Fred G. Bank
Acting Chief
Environmental Programs Branch
Office of Environmental Policy
Federal Highway Administration
Room 3232, HEF-12
400 Seventh Street, S.W.
Washington, DC 20590

Tel: (202) 366-2061
Fax: (202) 366-3409
**R/A**

Michael Bardecki
School of Applied Geography
Ryerson Polytechnical Institute
Toronto, Ontario

Tel:
Fax:
**RE**

Suzanne Barrett
Royal Commission on the Future
of Toronto Waterfront
207 Queen Quay West 5th Floor
P.O.Box 4111
Station A
Toronto, Ontario
M5W 2V4

Tel: (416) 973-7185
Fax: (416) 973-7103
**RE**

Gordon Beanlands
Director
Institute for Resource and
Environmental Studies (SRES)
Dalhousie University
1312 Robie Street
Halifax, Nova Scotia
B3H 3E2

Tel: (902) 494-3632
Fax: (902) 424-3728
**RE**

Barbara Bedford
Ecosystems Research Centre
Centre for Environmental Research
105 Wing Hall
Cornell University
Ithaca, N.Y.
14853

Tel: (607) 255-9447
Fax: (607) 255-5316
**RE**

John Belshe
Chief, Environmental Branch Planning Division
H.Q.U.S. Army Corps of Engineers (CECW-PP)
20 Massachusetts Av., N.W.
Pulaski Building, Room 7113C
Washington, DC 20314-1000

Tel: (202) 272-0166
Fax: (202) 272-1163
**P**

Glen Bloodworth
Director, Environmental Directorate
Indian and Northern Affairs Canada
Les Terrasses de la Chaudiere,
18th Floor
10 Wellington Street
Hull, Quebec
K1A 0H4

Tel: 997-8424
Fax: 953-1885
**R/A**

Peter Boice
Environmental Specialist
Office of Secretary of Defense
206 North Washington Street, Suite 100
Alexandria, VA 22314-2528

Tel: (202) 325-2215
Fax: (202) 325-2234
**P**

Carol Borgstrom
Director
Office of NEPA Project Assistance,
EH-25
U.S. Department of Energy
Room 3E-080
1000 Independence Av., S.W.
Washington, DC 20585

Tel: (202) 586-4600
Fax: (202) 586-7031
**P**

Curtis Bowling
HQ U.S.Air Force/LEEV
Bowling Air Force Base
Washington, DC 20331-5000

Tel: (202) 767-4178
Fax: (202) 767-3106
**P**

Bob Boulden
Environmental Impact Systems Division
Environmental Canada
Place Vincent Massey
Hull Quebec
K1A 0H3

Tel: 953-1690
Fax: 953-4093
**R/A**

Jessie Cavellon
Environmental Office Department
of the Army
Pulaski Building, Room 6123
20 Massachusetts Avenue, N.W.
Washington DC 20314-100

Tel: (703) 693-5032
Fax: (703) 693-7073
**P**

Jean Clerkey
Office of Environmental Policy
Federal Highway Administration
Room 3232, HEV1
400 Seventh Street, S.W.
Washington, DC 20590

Tel: (202) 366-2045
Fax: (202) 366-3713
**R/A**

Christopher R. Cocklin
Department of Geography/Environmental
Science
University of Auckland
Private Bag,
Auckland, New Zealand

Tel: 011-64-9-0-737-999
Fax:
**RE**

John Cohrssen
Council on Environmental Quality
722 Jackson Place N.W.
Washington, DC 20503

Tel: (202) 395-5750
Fax: (202) 395-3744
**RE**

David Cottingham
Ecology and Environmental Conservation Office
National Oceanic and Atmospheric Administration
Department of Commerce
HCHB, Room 6222
14th Street and Constitution Avenue, N.W.
Washington, DC 20230

Tel: (202) 377-5181
Fax: (202) 377-8203
**R/A, RE**

Gilles Couture
Gauthier and Guillemette Consultant Inc.
225 Mont Fort
Saint-Romuald, Quebec
G6W 3L8

Tel: (418) 839-6447
Fax: (418) 839-1419
**C**

Rick Crozier
Environmental Protection
BC Environment
6133 Vernon St.
Nelson, BC.
V1L 4E9

Tel: (604) 354-6355
Fax: (604) 354-6367
**R/A**

Dave Davies
Office of Wetlands Protection (A-104F)
Environmental Protection Agency
401 M Street, S.W.
Washington, DC 20460

Tel: (202) 475-8795
Fax: (202) 382-2356
**R/A, RE**

Gordon Davies
Acres International Ltd.
5259 Dorchester Road
Niagara Falls, Ontario
L2E 6W1

Tel: (416) 374-5257
Fax:
**C**

Wayne Deason
Manager, Environmental Services
Bureau of Reclamation
ATTN: D5150
P.O. Box 25007
Denver, CO 80225

Tel: (303) 236-6778
Fax: (303) 776-6763
**R/A**

James Densmore
Office of Environment and Energy AEE-1
Federal Aviation Administration
800 Independence Av., S.W.
Washington, DC 20591

Tel: (202) 267-3576
Fax: (202) 267-5594
**R/A**

Ramesh Desai
Environmental Office
Department of the Army
Pulaski Building, Room 6123
20 Massachusetts Avenue, N.W.
Washington, DC 20314-100

Tel: (703) 355-2103
Fax: (703) 355-7210
**P**

Andy Devito
Chief
Branch of Environmental and Economic Analysis
Office of Surface Mining,
Department of the Interior South
Building 5121 L
1951 Constitution Av., N.W.
Washington, DC 20240

Tel: (202) 343-5150
Fax: (202) 898-1291
**R/A**

Anthony Dorcey
Westwater Research Centre
#200-1933 West Mall
University of British Columbia
Vancouver, BC.
V6T 1W5

Tel:
Fax:
**RE, C**

Tony Downs
Director, Conservation and Environment
Department of National Defence
9th Floor, Centre Block North
101 Colonel By Drive
Ottawa, Ontario
K1A 0K2

Tel: 995-4154
Fax: 992-9422
**R/A**

Robert Everitt
ESSA
3rd Floor, 1765 West 8th Avenue
Vancouver, BC.
V6J 5C6

Tel:
Fax:

Bob Ferrari
Lavalin
1100 West Boulevard Rene Levesque
7th Floor
Montreal, Quebec

Tel: (514) 866-4451
Fax: (514) 953-4093
**C**

Patrick Fink
Secretary of the Air Force
(SAFBQ)
Room 4C916
The Pentagon
Washington, DC 20230-1000

Tel: (703) 697-9298
Fax: (703) 693-7568
**P**

Bernard Goode
Chief
Regulatory Branch
Operations Division
H.Q. U.S. Army Corps of Engineers (CECW-OR)
20 Massachusetts Av., N.W.
Pulaski Building. Room 6225
Washington DC 20314-1000

Tel: (202) 272-0116
Fax: (202) 272-1163
P

Robin Gregory
National Science Foundation
1800 G St., N.W. Room 336
Washington, DC 20550

Tel: (202) 357-7417
Fax: (202) 357-0357
**RE**

William Gummer
Inland Waters Directorate
Room 300, Park Plaza
2365 Albert Street
Regina, Saskatchewan
S4P 4K1

Tel: (306) 780-5322
Fax: (306) 780-5311
**R/A**

Andy Hamilton
Rawson Academy of Aquatic Science
1 Nicholas Street, Suite 404
Ottawa, Ontario
K1N 7B7

Tel: (613) 563-2636
Fax: (613) 563-4758
**RE, C**

Frank Harris
Executive Officer of Biological, Behavioral and Social Sciences
National Science Foundation
1800 G St., N.W. Room 506
Washington, DC 20550

Tel: (202) 357-9880
Fax: (202) 357-7059
**RE**

Jim Hester
U.S. Agency for International Development
Room 2239
2201 C Street, N.W.
Washington, DC 20523

Tel: (202) 647-7059
Fax: (202) 647-8093
**R/A**

Richard R. Hoffmann
Chief
Division of Engineering
Marketing and Environmental Analysis
Office of Pipeline and Producer Reg.,
PR 21.3
Federal Energy Regulatory Commission
825 N. Capitol St., N.E.
Washington, DC 20426

Tel: (202) 208-0066
Fax: (202) 208-0147
**R/A**

Jacob J. Hoogland
Chief
Environmental Compliance Division
National Park Service
(Mail Stop 726)
Department of the Interior
P.O. Box 37127
Washington, DC 20013

Tel: (202) 208-3163
Fax: (202) 208-4298
**R/A**

Rick Hoos
Suite 2000, 111 Fifth Avenue SW
Trans Canada Pipeline Tower
Calgary, Alberta
T2P 3Y6

Tel: (416) 267-2665
Fax:
**P**

Gerry Horak
TGS Technology
P.O. Box 9076
Fort Collins, CO 80525

Tel: (303) 224-4996
Fax: (303) 226-9230
**C**

Pamela Hubbard
Environmental Office
Ontario Ministry of Transportation
2nd Floor, West Building
1201 Wilson Avenue
Downsview, Ontario
M3M 1J8

Tel: (416) 235-3478
Fax: (416) 235-4922
**R/A**

Carolyn Hunsaker
Environmental Sciences Division
Oak Ridge National Laboratory
Building 1505
P.O. 20008
Oak Ridge, TN 37831-6038

Tel: (615) 574-7365
Fax:
**RE**

Frances Irwin
World Wildlife Fund/Conservation Foundation
1250 24th Street, N.W.
Washington, D.C. 20037

Tel: (202) 778-9646
Fax: (202) 293-9345
**RE**

Richard Johnson
Fish and Wildlife Service
National Ecology Centre
Creekside One Building
2627 Redwing Road
Fort Collins, CO 80526-2899

Tel: (303) 226-9434
Fax: (303) 226-9230
**R/A, RE**

Timothy Julius
Environmental Compliance and Planning Division
Army Environmental Office
Pulaski Building, Room 6123
20 Massachusetts Avenue, N.W.
Washington, DC 20314-100

Tel: (703) 693-5032
Fax: (703) 693-7073
**P**

Bryan Kelso
Environment Canada
Consaervation & Protection
224 West Esplanade
North Vancouver, BC.
V7M 3H7

Tel: (604) 666-5193
Fax: (604) 666-6858

David E. Ketcham
Director
Environmental Coordination Staff Forest Staff
Department of Agriculture
South Agriculture Building, Room 4204
14th St. and Independence Ave., S.W.
P.O. Box 96090
Washington, DC 20090-6090

Tel: (202) 447-4708
Fax: (202) 382-8225
**R/A, RE**

David Kiell
Environmental Service
Newfoundland and Labrador Hydro
P.O. Box 12400
St. John's, Newfoundland
A1A 2Xb

Tel: (709) 737-1494
Fax:
**P**

Kheryn Klubnikin
Environmental Compliance Division
National Park Service
(Mail Stop 726)
Department of the Interior
P.O. Box 37127
Washington, DC 20013

Tel: (202) 208-4168
Fax: (202) 2084298
**R/A**

Roy Kwiatkowski
Office of Environmental Affairs
Department of Energy, Mines and Resources
580 Booth Street
Ottawa, Ontario
K1A 0E4

Tel: 995-3866
Fax: 995-5719
**R/A**

Nuz Khan
Fish Habitat Management Branch
Department of Fisheries and Oceans
200 Kent Street
Ottawa, Ontario
K1A 0E6

Tel: 990-0199
Fax: 990-9764
**R/A**

Louise Kingsley
Environmental Assessment Coordinator
National Capital Commission
161 Laurier Avenue West
Ottawa, Ontario
K1P 6J6

Tel: 239-5591
Fax: 239-5393
**R/A**

Yvonne Knaebel
Environmental Coordination Specialist
U.S. Department of Agriculture
Forest Service
Southern Region
Planning and Budget
1720 Peachtree Road, N.W.
Atlanta, GA 30367

Tel: (404) 347-5213
Fax: (404) 347-4448
**R/A, RE, P**

Patricia Lane
P. Lane & Associates Ltd.
5439 Cogswell Street
Halifax, Nova Scotia
B3J 1R1

Tel: (902) 423-8197
Fax: (902) 429-8090
**RE, C**

Patrice LeBlanc
Director of Research
Federal Environmental Research Office
13th Floor, Fontaine Building
200 Sacre Coeur Blvd.
Hull, Quebec K1A OH3

Tel: (613) 997-2253
Fax: (613) 994-1469
**RE, R/A**

Scott G. Leibowitz
Research Ecologist
U.S. Environmental Protection Agency
Environmental Research Laboratory
Corvallis, OR. 97333

Tel: (503) 757-4666
Fax: (503) 757-4335
**RE**

Betsy Lyons
Research Fellow
The Conservation Foundation
1250 24th Street, N.W.
Washington, D.C. 20037

Tel: (202) 778-9646
Fax: (202) 293-9345
**RE**

Pierre Martel
Academie LaSalle
373 Sussex Drive
Ottawa, Ontario
K1A OH3

Tel: (819) 953-4457
Fax: (819) 953-7632
**RE, R/A**

Michael Lawrence
North/South Consultants Inc.
2nd Floor, 1475 Chevier Boulevard
Winnipeg, Manitoba

Tel: (204) 284-3366
Fax: (204)
**C**

Gary Leitch
AECL
Whiteshell Laboratories
Pinawa, Manitoba
R0E 1L0

Tel: (204) 753-2311
Fax: (204) 753-2455
**P**

Robert Malvern
Environmental Studies and Assessments
Ontario Hydro
700 University Avenue, H10G5
Toronto, Ontario
M5G 1X6

Tel: (416) 592-4071
Fax: (416) 978-0156
**P**

Carol Miller
Office of Science Advisor
Environment Canada
Jules Leger Building,
14th Floor
25 Eddy Street
Hull, Quebec K1A OH3

Tel: (819) 953-9608
Fax: (819) 953-0550
**RE, R/A**

Cammille Mittelholtz
U.S. Department of Transportation
Office of the Secretary of Transportation
Federal Highway Administration
400 Seventh Street, S.W.
Room 9217
Washington, DC 20590

Tel: (202) 366-4861
Fax: (202) 366-7618
**R/A, P**

James Newman
Director, Ecological Sciences Division
Soil Conservation Service
P.O. Box 2890
Washington, DC 20013

Tel: (202) 447-2587
Fax: (202) 447-2646
**RE**

Murray Paterson
Environmental Studies and Assessments
Ontario Hydro
700 University Avenue, H10G4
Toronto, Ontario
M5G 1X6

Tel: (416) 592-6007
Fax: (416) 978-0156
**P**

Tom Peeling
Special Advisor for Environmental Planning
Department of the Navy
Naval Facilities Engineering Command
200 Stovall St., Room 10S67
Alexandria, VA 22332

Tel: (703) 325-7344
Fax: (703) 325-2262
**P**

Sandra Needham
Bureau of Environmental Sustainability
Building 94
Agriculture Canada
Ottawa, Ontario
K1A 0C5

Tel: 995-7084
Fax: 995-3845
**R/A**

Carolyn Osborne
Office of NEPA Project Assistance, EH-25
Room 3E-080
U.S. Department of Energy
1000 Independence Av., S.W.
Washington, DC 20585

Tel: (202) 586-4600
Fax: (202) 586-7031
**R/A, P**

Paul E. Petty
Environmental Coordinator
Bureau of Land Management
Department of the Interior
Premier Building, Room 106
18th and C Street, N.W.
Washington, DC 20240

Tel: (202) 653-8824
Fax: (202) 653-9118
**R/A**

Don Peterson
Environmental Coordinator
Fish and Wildlife Service (EHC-BFA)
Federal Activities Branch
Washington, DC 20240

Tel: (202) 235-2418
Fax: (202) 226-9230
**R/A, RE**

Sharon Pfeiffer
ANE/PD/ENV
U.S. Agency for International Development
Room 3313A
2201 C Street, N.W.
Washington, DC 20523

Tel: (202) 647-8226; 647-6964
Fax: (202) 647-8098
**R/A, RE**

Darrell Piekarz
Environment Canada Regional Office
25 St. Clair Avenue East
6th Floor
Toronto, Ontario
M4T 1M2

Tel: (416) 973-7490
Fax: (416) 973-7439
**R/A**

Martin Pomeroy
Environmental Protection
Pacific and Yukon Territory
Kapliano 100-Park Royal South, 3rd Floor
West Vancouver, BC.

Tel: (604) 666-3220
Fax: (604) 666-6281
**R/A**

Anna Quandt
U.S. Agency for International Development,
PTC/PDPR
Room 3893NS
2201 C Street, N.W.
Washington, DC 20523

Tel: (202) 647-7040
Fax: (202) 647-8098
**R/A, RE**

Lynne S. Pickard
Manager, Community and
Environmental Needs Division, APP-600
Federal Aviation Administration
800 Independence Av., S.W.
Washington, DC 20591

Tel: (202) 267-3263
Fax: (202) 376-1526
**R/A**

David Policansky
Commission on Life Sciences
National Research Council
2101 Constitution Avenue, N.W.
Washington, DC 20418

Tel: (202) 334-2540
Fax: (202) 334-2752
**RE**

Eric M. Preston
Environmental Research Laboratory
U.S. Environmental Protection Agency
200 S.W. 35th Street
Corvallis, OR 97333

Tel: (503) 757-4666
Fax: (503) 757-4335
**R/A, RE**

Debbie Ramsay
Niagara Escarpment Commission
232 Guelph Street
Georgetown, Ontario
L7G 4B1

Tel: (416) 877-5191
Fax: (416) 877-5194
**R/A, RE**

Christina Ramsey
Director for Environmental Planning
Office of Secretary of Defense
206 North Washington Street, Suite 100
Alexandria, VA 22314-2528

Tel: (202) 325-2215
Fax: (202) 325-2234
**P**

Henry Regier
Director
Institute for Environmental Studies
University of Toronto
Toronto, Ontario
M5S 1A4

Tel: (416) 978-7338
Fax: (416) 978-8532
**RE**

Louise Roy
3855 avenue Northcliffe
Montreal, Quebec
H4A 3K9

Tel: 514) 481-2576
Fax:
**C**

Barry Sadler
Institute of the North American West
1631 Barksdale Drive
Victoria, B.C.
N8N 5A8

Tel: (604) 477-8752
Fax: (604) 477-8952
**C**

Robert M. Reed
Environmental Science Division
Oakridge National Laboratory
Building No. 1501, Mail Stop 6036
Oakridge, TN 37830

Tel: (615) 574-7308
Fax: (615) 576-8543
**RE**

Rick Rice
Chief of Naval Operations
Department of Environment, Safety and Health
CP5 Room 654
2211 Jefferson Davis Highway
Arlington, VA 22202

Tel: (703) 602-2569
Fax: (703) 602-4642

Thomas Russo
Office of Hydropower Licensing Chief
Planning and Support Branch HL20.3
Federal Energy Regulatory Commission
825 N. Capitol St., N.E.
Washington, DC 20426

Tel: (202) 219-2792
Fax: (202) 208-0147
**R/A**

Michael Schopf
Associate General Counsel
Enforcement, General Law, and Rulemaking, GC-13
Federal Energy Regulatory Commission
825 N. Capitol St., N.E.
Washington, DC 20426

Tel: (202) 208-0597
Fax: (202) 208-0147
**R/A**

Jeff Schweitzer
Environmental Policy Analyst
U.S. Agency for International
Development, PPC/TDR
Room 3894, New State
Washington, DC 20523

Tel: (202) 647-7052
Fax: (202) 647-8098
**R/A, RE**

Steve Seidel
Office of Program Development
Office of Air and Radiation
Environmental Protection Agency
401 M Street, S.W.
Washington, DC 20460

Tel: (202) 382-2787
Fax: (202) 382-7883
**R/A, RE**

Nicholas C. Sontag
ESSA
3rd Floor, 1765 West 8th Avenue
Vancouver, B.C.
V6J 5C6

Tel: (604) 689-2912
Fax: (604) 682-2114
**C**

Harry Spaling
Department of Geography
University of Guelph
Guelph, Ontario
N1G 2W1

Tel: (519) 824-4120
Fax:
**RE**

Stuart Sears
Environmental Studies and Assessment
Branch
Ontario Hydro
700 University Avenue
Toronto, Ontario
M5G 1X6

Tel: (416) 592-7307
Fax: (416) 978-0156

Dean L. Shumway
Director
Division of Project Review
Office of Hydropower Licensing HL20
Federal Energy Regulatory Commission
825 N. Capitol St., N.E.
Washington, DC 20426

Tel: (202) 219-2770
Fax: (202) 208-0147
**R/A**

Anne Snider
Environmental Assessment Division
Northern Environmental Protection
Directorate
Indian and Northern Affairs
Les Terrasses de la Chaudiere 6th Floor
Hull, Quebec
K1A 0H4

Tel: 997-0046
Fax: 994-6419
**R/A**

Eugene Stakhiv
U.S. Army Corps of Engineers
Institute of Water Resources
Casey Building
Fort Belvoir, VA 22060

Tel: (703) 355-2468
Fax: (703) 355-3171
**P**

Steve Starley
Manager, Policy and Regulatory
Division, AEE-300
Federal Aviation Administration
1419 Fallsmead Way
Rockville, MD 20854

Tel: (202) 267-7023
Fax: (202) 267-5716
**R/A**

David Stout
Fish and Wildlife Service (EHC-BFA)
Federal Activities Branch
Washington, DC 20240

Tel: (202) 235-2418
Fax: (202) 226-9230
**R/A, RE**

Judy Troast
Office of Wetlands Protection (A-104)
Environmental Protection Agency
401 M Street, S.W.
Washington, DC 20460

Tel: (202) 382-5905
Fax: (202) 382-7883-6
**R/A, RE**

Russell Theriot
Manager
Wetland Research Program
U.S. Army Corps of Engineers
Waterways Experiment Station
P.O. Box 631
Vickburg, MISS 39180-0631

Tel: (601) 634-2733
Fax:
**RE**

Zell Steever
Office of Operations and Readiness
H.Q. U.S. Army Corps of Engineers (CECW-OR)
20 Massachusetts Av., N.W.
Pulaski Building, Room 6225
Washington, DC 20314-1000

Tel: (202) 272-1780
Fax: (202) 504-4197
**P**

Elizabeth Stull
Argonne National Laboratory
Energy and Environmental Systems Division
9700 South Cass Avenue
Argonne, IL 60439

Tel: (708) 972-7801
Fax: (708) 972-2206
**RE**

Charles Terrell
Ecological Sciences Division Soil
Conservation Service
P.O. Box 2890
Washington, DC 20013

Tel: (202) 447-4925
Fax: (202) 447-2646
**R/A, RE**

Bill Trotter
Environmental Sciences Division
Public Works Canada
Sir Charles Tupper Building, Room C-446
Riverside Drive
Ottawa, Ontario
K1A 0M2

Tel: 998-1108
Fax:
**R/A**

Ron Wallace
Dominion Ecological Consulting Ltd.
540 5th Avenue SW, Main Floor
Calgary, Alberta
T2P 0M2

Tel: (403) 262-7310
Fax: (403) 266-3179
**C**

Bob Weir
Director of Environment
Professional Services Branch
CIDA
Room 735, 7th Floor
Hull, Quebec
K1A 0G4

Tel: 997-6731
Fax: 997-4762
**R/A**

Leslie Whitby
State of the Environment Reporting
Place Vincent Massey, 10th Floor
351 St. Joseph Boulevard
Hull, Quebec
K1A 0H3

Tel: 997-4149
Fax: 953-3972
**R/A**

Richard Wildermann
Chief
Branch of Environmental Evaluation
Minerals Management Service
12203 Sunrise Valley Drive
Reston, VA 22091

Tel: (703) 648-7857
Fax: (703) 787-1010
**R/A**

George Wallen
Ecological Resources Division
Bureau of Reclamation
ATTN: D5500
P.O. Box 25007
Denver, CO 80225

Tel: (303) 236-6778
Fax: (303) 776-6764
**P**

Glen Whaley
Environmental Office
U.S. Agency for International Development
Room 3321A
2201 C Street, N.W.
Washington, DC 20523

Tel: (202) 647-6965
Fax: (202) 657-8098
**R/A**

Molly R. Whitworth
Ecologist
Science Policy Integration Branch
Office of Policy Analyst (PM-220)
Environmental Protection Agency
401 M Street, S.W.
Washington, DC 20460

Tel: (202) 382-5869
Fax: (202) 382-7885
**R/A, RE**

Dale V. Wilhelm
Environmental Quality Staff
Tennessee Valley Authority
229 Summer Place Building
Knoxville, TN 37902

Tel: (615) 632-6693
Fax: (615) 632-6855
**R/A**

Sam Williamson
Fish and Wildlife Service
National Ecology Centre
Creekside One Building
2627 Redwing Road
Fort Collins, CO 80526-2899

Tel: (303) 226-9362
Fax: (303) 226-9230
**R/A, RE**

Jim Young
SENES
52 West Beaver Creek Road
Unit No.4
Richmond Hill, Ontario
L4B 1G5

Tel: (416) 764-9380
Fax: (416) 764-9386
**C**

Lance Wood
Office Chief Counsel
H.Q. U.S. Army Corps of Engineers (CECC-E)
20 Massachusetts Av., N.W.
Pulaski Building, Room 8215
Washington, DC 20314-1000

Tel: (202) 272-8556
Fax: (202) 504-4123
**P**

Jeffrey Zippin
Chief
Branch of Environmental Operations
Minerals Management Service
(MS-664)
12203 Sunrise Valley Drive
Reston, VA 22091

Tel: (703) 648-7770
Fax: (703) 787-10105

## LIST OF INITIATIVES ON CUMULATIVE ENVIRONMENTAL EFFECTS

Note: There is a growing number of initiatives focusing on including environmental considerations in regional and land use planning. These initiatives have not been included unless they explicitly mention cumulative environmental effects.

Canadian Environmental Assessment Research Council (CEARC)

CEARC has had an initiative on cumulative environmental effects since 1984. The initial work focused on classifying cumulative effects, scoping the concept of cumulative effects assessment and identifying research needs. The Council has published several reports on cumulative effects assessment including:

Canadian Environmental Assessment Research Council and the U.S. National Research Council. 1986. "Cumulative Effects Assessment: A Binational Perspective";

Sonntag, N., R.R. Everitt, L.P. Rattie, D.L. Colnett, C.P. Wolf, J.C. Truett, A.H. Dorcey, and C.S. Holling. 1987. "Cumulative Effects Assessment: A Context for Further Research and Development";

Peterson, E.B., Y.H.Chan, N.M.Peterson, G.A.Constable, R.B.Caton, C.S.Davis, R.R.Wallace and G.A. Yarranton. 1987. "Cumulative Effects Assessment in Canada: An Agenda for Action and Research";

Canadian Environmental Assessment Research Council. 1988. "The Assessment of Cumulative Effects: A Research Prospectus".

Following up on recommendations in its Research Prospectus, the Council commissioned a study on the development of a reference guide on cumulative effects assessment. The study resulted in a series of reports that will be published in the Council's Manuscript Series. These reports are:

Lane, P., R.R. Wallace, R.L. Johnson, and D. Bernard. (1988), "Volume 1: Reference Guide to Cumulative Effects Assessment in Canada";

Wallace, R.R. and P. Lane. (1988), "Volume II: Feasibility Study in CEARC Cumulative Effects Assessment (CEA) Wetlands of the Boreal Agricultural Fringe of the Prairie Provinces; and

Sonntag, N., P. Lane, R. Wallace, B. Marcotte and S. James (1988), "Volume III: Overview of Agencies and Institutions Interested in Cumulative Effects Assessment and Management".

The second of the Manuscript Series reports describes a cooperative study with the U.S. National Research Council. The multi-phased study proposed to use the loss of prairie wetlands as a demonstration project on cumulative effects assessment. Following the completion of the first phase which consisted of a series of consultation meetings and workshop, the Council decided not to pursue the study any further. A report has been prepared summarizing the result of the work carried out in this phase of the proposal ("Report of Phase I of Proposed Canada/U.S. Research Project on Cumulative Loss of Prairie Wetlands" by Lee Munn).

Contact:
Patrice LeBlanc
Tel: (819) 997-2253
Fax: (819) 994-1469

Federal Environmental Assessment Review Office (FEARO) - Proposed Canadian Environmental Assessment Act

The proposed Canadian Environmental Assessment Act (CEAA) will require federal proponents to assess the cumulative environmental effects of their projects. A consultant has been retained to examine possible approaches to cumulative effects assessment in the context of the new legislation. A short background paper has been prepared and a workshop was held in February, 1991 for federal departments. The results of this workshop and other regional consultations will be used to prepare an advisory reference document to guide federal departments in dealing with cumulative environmental effects, as required under the new CEAA. Plans

are to review the advisory reference document at a second workshop in late 1991, to include some case studies and offer reference material for managers.

Contact:
Patrice LeBlanc
Tel: (819) 997-2253
Fax: (819) 994-1469

Office of the Science Advisor, Environment Canada

The Office of the Science Advisor is interested in initiating a project on cumulative environmental effects. It is likely that this will focus on examining the feasibility of conducting cumulative effects assessments at a regional level (i.e., for environmental monitoring purposes, in the absence of a specific project or proponent). Possible initiatives include: identifying and mobilizing the expertise in cumulative environmental effects; identifying potential clients for ecological assessments; NSERC chairs in environmental studies with a focus on ecological assessment/cumulative environmental effects.

Contact:
Carol Miller
Tel: (819) 953-9608
Fax: (819) 953-0550

Inuit Tapirisat of Canada (ITC) - Hudson/James Bay Basins

The Inuit Tapirisat of Canada (ITC) have written to the Minister of the Environment outlining their concerns about the cumulative impacts of the proposed hydro developments in Ontario, Quebec and Manitoba on the Hudson/James Bay Basins. They have expressed concerns about the biophysical, social and economic cumulative effects, most notably on the Inuit and Cree peoples. The Inuit Tapirisat of Canada (ITC) is proposing a workshop to inform aboriginal

communities about possible cumulative environmental effects of proposed hydro developments, to scope priorize the scientific and social issues.

Contact:
Lloyd Gamble
Tel: (613) 238-8181
Fax: (613) 234-1991

Quebec Hydro - Grande Baleine

Mr. Gilles Couture of Gauthier and Guillemette Consultant Inc. has been retained by Hydro Quebec to review cumulative environmental effects and to identify methods and techniques that could be used to address cumulative impacts. The consultant is to make recommendations about the approach and methods that would be used to assess cumulative effects for the Grande Baleine project.

Contact:
Gilles Couture
Tel: (418) 839-6447
Fax: (418) 839-1419

Environment Canada/Alberta Environment - Joint Study on the Peace, Athabasca and Slave River Systems in Alberta

This joint federal/provincial study will include studies on water, plants, animals and human uses of these rivers. It will include a study of the distribution and habitat of fish in the rivers, including tributaries, such as the Wapiti and Smoky Rivers. This study was recommended by the Alberta/Pacific Environmental Impact Assessment Review Board. Participants include the Alberta Departments of Environment and Forestry, Lands and Wildlife; the federal Departments of Environment, Fisheries and Oceans and Indian and Northern Affairs and the Government of the Northwest Territories. The study is estimated to cost $10 million and to take approximately three

years to complete. The study participants are currently (spring, 1991) examining how to operationalise the concept of cumulative environmental effects in the monitoring program.

Contact:
Bill Gummer
Tel: (306) 780-5422
Fax: (306) 780-5311

Ontario Hydro - Moose River Basin

Ontario Hydro's Demand/Supply Plan contains proposals to develop the remaining hydraulic potential in Ontario. The Moose River Basin in northern Ontario has considerable hydraulic potential. The Basin consists of three main tributaries: the Mattagami, the Abitibi and Missinaibi, all flowing into the Moose River which empties into James Bay. Ontario Hydro is proposing to develop six new hydro electric generating stations and to expand six existing facilities. It will be assessing cumulative environmental effects of these proposed hydro developments on a basin-wide scale through a plan assessment process that will emphasise cumulative environmental effects. A multistakeholder workshop was held in Timmins in February to discuss the plan assessment process.

Contacts:

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| Robert Malvern | Murray Paterson |
| Tel: (416) 592-6007 | Tel: (416) 592-4071 |
| Fax: (416) 978-0156 | Fax: (416) 978-0156 |

Parks Canada - Parks Management Plans

A project being undertaken by Environmental Research Associates for the Canadian Parks Service involves the assessment of cumulative environmental effects.

The purpose of the project is to develop and conduct environmental screenings for two Park Management Plans--Point Pelee National Park and Pukaskwa National Park. The Canadian

Parks Service has not yet developed or applied standardized guidelines for conducting environmental screenings of its Park Management Plans. The guidelines will be grounded in existing policies, directives, or guidelines, and will take into account the requirements of the proposed Canadian Environmental Assessment Act. The guidelines will therefore consider the cumulative environmental effects of proposed facilities or activities in relation to existing facilities of activities within the parks, and in relation to regional activities outside the boundaries of the Parks. In addition, the Western Region of Parks Canada has retained a consultant to examine the cumulative environmental effects in the Bow Valley area of the Banff National Park.

Contact:

Tel: (819) 994-5533
Fax: (819) 994-5140

Environment Canada - Federal Program Review Project

The Green Plan commits the federal government to undertaking a comprehensive review of the environmental implications of its existing statutes, programs, policies and regulations and to put in place measures to mitigate the consequences or reinforce the benefits. It has been recognized that there may be no significant environmental impacts when programs are assessed on an individual basis, but when they interact together and with other non-federal activities in the field, there may be cumulative environmental effects. There is a proposal to undertake an assessment of the long term sustainability of whole ecosystems or regions, recognizing that such an assessment will be difficult and precedent setting. To address the cumulative environmental impacts of existing programs, an experimental study focusing on two selected ecosystems or regions in Canada will be conducted in the first two years of the Federal Program Review Project.

Contact:
Pierre Martel
Tel: (819) 953-4457
Fax: (819) 953-7632

Ministry of Municipal Affairs - "Greening of the Planning Act"

A study to determine if, and how cumulative environmental effects can be addressed within Ontario's land use planning process is being conducted by the Ontario Ministry of Municipal Affairs, Municipal Planning Policy Branch.

Contact:
Wendy Noble
Tel: (416) 585-6225
Fax: (416) 585-7540

Federal Environmental Assessment Review Office (FEARO)/Environment Canada - Monitoring for Cumulative Environmental Effects

FEARO and Environment Canada are jointly funding a study reviewing six monitoring programs in aquatic ecosystems to examine if, and how they monitor cumulative environmental effects. The six case studies include the Fraser River Estuary and the Peace, Athabasca and Slave Rivers. The programs will be compared and contrasted to identify any guiding principles for monitoring for cumulative environmental effects. The project is due to be completed by the end of March, 1991.

Contacts:

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| Patrice LeBlanc | Bob Baker |
| Tel: (819) 997-2253 | Tel: (613) 953-1693 |
| Fax: (819) 994-1469 | Fax: (613) 953-4093 |

Atmospheric Environment Service - Regional Impacts of Projected Global Warming on the Mackenzie Basin

The Atmospheric Environment Service of Environment Canada will be coordinating a multi year, multi disciplinary study of global warming in the Mackenzie Basin. This study will provide useful information to assist in understanding the impacts of global warming on northern ecosystems.

Between three and five scenarios for global warming will be chosen and the likely cumulative environmental effects on the physical and human environments will be predicted. In particular, the study will be investigating the physical, biological, socio-economic and regional impacts and the interactions between them.

Contact:
Stuart Cohen
Tel: (416) 739-4389
Fax: (416) 739-4521

Niagara Escarpment Commission - Niagara Escarpment Plan

The Niagara Escarpment Plan states that cumulative environmental effects should be taken into account in development control decisions in the area. Recently, as part of the evaluation of the Plan, the Commission decided to examine how this could be done in practical terms. A report will be prepared in the near future.

Contact:
Debbie Ramsay
Tel: (416) 877-5191
Fax: (416) 877-5194